OPERATIVE DENTISTRY.

A

PRACTICAL TREATISE

ON

OPERATIVE DENTISTRY.

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PREFACE.

THIRD EDITION.

So great have been the changes, in almost every branch of Dental Practice, since the publication of the second edition of this work, that the labor involved in the preparation of a new one has been little less than the writing of an entirely new work.

During the last few years many new instruments, appliances and modes of practice, have been introduced, that have proved very valuable, and are in use by the profession, superseding in many cases others less efficient, while others, again, have become wholly obsolete or comparatively worthless. It has therefore become necessary to omit many illustrations with descriptions of them, but so many more have been added that are now regarded as desirable and of great practical value, as to greatly increase the whole number.

The general scope and plan of the work has not been changed, or any material modification made, except adapting it more fully to the present advanced state of the science. An Appendix has been

added, presenting some subjects more fully than could be satisfactorily done in the body of the work.

The author, in conclusion, cannot refrain from expressing the hope that this edition will be as favorably received as the previous ones, and prove instrumental in promoting the best interests of the profession.

CINCINNATI, *January*, 1877.

PREFACE.

SECOND EDITION.

The preparation of the present edition of this work has been attended with more labor and effort than the author had anticipated.

The first edition, at the time of its writing, was designed to embody and present the principles and practice of the profession in the operative department, in its highest attainment.

Since that time, however, so great have been the changes in many points of practice and application of principles, that those given as the best, nine years ago, are superseded by others and out of use; so that in many particulars the labor has been almost equal to the preparation of new matter.

The object in this, as in the former edition, has been to bring the work up to the present status of the profession; and though it has been accomplished with many misgivings and consciousness of defects, the author is not without hope that it may be of value to those preparing to enter the profession, if not to those already in it.

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OPERATIVE DENTISTRY.

CHAPTER I.

INTRODUCTION.

Introductory to the following treatise, some consideration of those conditions and diseases of the teeth which require the aid of the dental surgeon, seems appropriate. To refer, however, to all of these, or to remark at length upon any of them, is not consistent with the design of this work, or necessary to a proper understanding of the subjects proposed. Only those affections which pertain to the teeth directly, and the contiguous parts, will here be considered; and the latter only so far, in the main, as surgical treatment is concerned. Nor will the pathology of contiguous parts be introduced; for the treatment of these, being mainly therapeutic rather than surgical, would involve a discussion of questions not within the scope of the present volume. Indeed, it is proposed merely to speak of

those affections of the teeth which generally suggest surgical remedies, and which are implicated more or less in the operations described in the following pages; and first, of

DEPOSITS.

In this term are included those calcareous formations commonly called *tartar*, a certain coloring matter denominated *green or brown stain*, and such other impurities on the teeth as result from neglect, the use of tobacco, and like causes. The word

TARTAR

implies all calcareous deposits upon the teeth. Of this substance there are several varieties, the more obvious of which have respect to color, composition and consistence. In color, there are all shades, from a white, with slight yellow tint, to a jet black; and in consistence, all degrees, from a thick, gummy mucus, to nearly the density of the dentine itself. The color will, in most cases, be indicative of the density, the lightest shade corresponding with the softest, and the darkest with the hardest consistence; there will, however, be found some variation in this respect. The tenacity to the teeth is also in proportion to the density, the dense and dark adhering

most firmly. The character of the surface of the tooth upon which the deposit is made, somewhat modifies the firmness of attachment. The density of the deposit, too, is generally indicative of the rapidity of its formation, being in an inverse ratio to this.

All the varieties of tartar are composed largely of the same materials; though the proportions vary much in different cases,—phosphate of lime, fibrin, fat, and animal matter, being contained in them all. The fact that some varieties are soluble in acids, and others not, has been adduced to prove that they are entirely different in their composition. This, however, is accounted for on another hypothesis: in the softer varieties, the phosphate of lime is so protected by the fat and the animal matter that, under ordinary circumstances, acid can not come in contact with it; but the dense varieties are very soluble, because the acid readily comes in contact with the calcareous material.

Its Origin.—The calcareous constituents of tartar are brought into the mouth in a state of solution in the saliva, being secreted from the blood with that fluid; while fats and other animal matter are accumulated from food, waste from the surface of the mucous membrane, and other residual matter from the mucus, and perhaps the saliva as well.

This calcareous material, which consists chiefly of

phosphate and carbonate of lime, is precipitated from the saliva, by the presence, influence and operation of several agencies.

The saliva, immediately after passing from the ducts into the mouth, undergoes a change by absorption of oxygen; intermingling with mucus and various foreign matters in the oral cavity, and variations of temperature, that greatly diminish its solvent power for the earthy salts referred to. Precipitation now takes place, and lodgment is made upon the most susceptible body and point presented.

Normal saliva always holds in solution more or less of this material; and sometimes the agencies above referred to are not sufficient to reduce its solvent power to the point of precipitation, or letting go the material held in solution. It is very probable that in some cases the saliva, very soon after being projected into the mouth, undergoes change, independent of the causes of which mention has been made, quite sufficient to permit precipitation of the salts of lime it contains.

Persons of a lymphatic temperament, or a tendency toward it, with muscles of a soft, flabby texture, hair light, teeth of a rather inferior quality, and a free flow of saliva, are most subject to the accumulation of tartar; yet there are conditions of almost all constitutions in which it is freely formed. That it is pre-

cipitated from the saliva, is a fact so easily demonstrated and so generally admitted, that it need not here be considered.

Points of Deposit.—The points at which salivary calculus is deposited in the greatest quantities upon the teeth, are in the vicinity of the orifices of the salivary ducts; and hence it is found most abundant on the lingual surfaces of the inferior anterior teeth, and on the buccal surfaces of the superior molars. Frequently, also, it collects in considerable quantities upon the external surfaces of the inferior front teeth. The points to which it most readily attaches, are at the necks of the teeth, immediately beneath the free margin of the gum, and at the termination of the enamel where it is thickest. A nucleus once formed, and it encroaches upon the crown of the tooth, if no means are employed to prevent its lodgment, at a rate determined by the condition of the saliva and the changes to which it is subject.

It is deposited first and most abundantly on the necks of the teeth, because here the saliva first comes in contact with these organs, and here remains for the longest periods and in the largest quantities. That it is precipitated very soon after the saliva enters the mouth, is evident from the fact that it is found collected upon the superior molars, just in the vicinity of the orifices of the ducts of Steno, where

the saliva cannot be retained for any considerable time, by reason of the position, but must very soon pass along upon the surfaces of the contiguous teeth, on which it is generally found deposited in much smaller quantities. Such is the condition of the saliva sometimes, either from being surcharged with the calcareous material, or from weakness of solvent power, that precipitation takes place before elimination of the saliva from the ducts; and so masses of the solid substance have been found in the duct passages; and in a few instances have been found imbedded in the salivary glands. Tumors are thus sometimes found that seem involved in great obscurity, and occasion intense and prolonged suffering.

Its Effects.—It exercises no directly injurious influence upon the substance of the teeth; but it is highly prejudicial to the parts immediately in connection with them, and upon which they depend for support. It encroaches upon the gums and alveoli, and causes absorption of these important surroundings; and as they become destroyed, its encroachments are continued and accelerated. In some constitutions this process goes on with little or no annoyance to the patient; while in others, irritation, inflammation, and even suppuration of the gums, occur; and thus their destruction is effected in a twofold manner. This irritation and inflammation may extend to the mucous

membrane, and involve all the adjacent parts. The dental periosteum will usually become implicated; periostitis will ensue, and often suppuration, thus breaking up the attachments of the teeth even before the surroundings are removed. The alveolus, too, becomes diseased, and in some instances its death and exfoliation result. Salivary calculus, however, never induces caries of the teeth, nor even favors it, except by inducing disease in the surrounding parts. On the contrary, we frequently meet with instances of decay entirely arrested and deposit of tartar in the cavity.

Persons of all ages are subject to this affection; those past middle life being most so, and those advanced in years sometimes having teeth nearly covered with tartar. Occasionally to such an extent

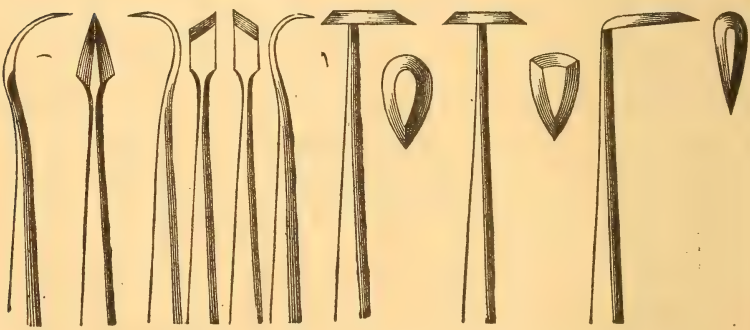
Fig. 1.

do the roots become invested with it that the teeth drop from the sockets. There are some constitutions whose diathesis is favorable to a deposition of salivary calculus through life. Others, again, will be entirely exempt from it till some peculiar constitu-

tional change intervenes, when it will begin to be rapidly produced.

Method of Removing it.—The removal of salivary calculus is an operation that does not involve a great amount of skill, but, with suitable appliances, is easily performed. There are two methods of effecting it; the one, that of scaling and scraping, and the other, that of decomposing the deposit by the application of an acid. The former is always to be preferred; for, in the latter, the chemical action of the acid does not stop with a decomposition of the deposit, but, by the same affinity, and nearly as readily, attacks the tooth itself. For the successful accomplishment of the operation, instruments of various forms and curves will be necessary, adapted

Fig. 2.



and adjusted to the various shapes and situations of the surfaces to be operated upon. The most common forms are represented in the above figure. The

blade of the instrument should be applied at a slightly obtuse angle with the surface of the tooth, just beyond the edge of the deposit next the gum, and thus passed under the tartar, scaling it off to the point in such a manner as not to cut or abrade the enamel. Deposits of this substance on proximal surfaces of the teeth are to be carefully observed, and removed with instruments of attenuated blades. When the thick incrustations have been thus removed, the surface should then be gently scraped, so as entirely to clean off all remaining portions, and afterward thoroughly polished with fine pumice, Arkansas or rotten-stone, and finished by burnishing. During the operation, a frequent employment of the toothbrush with water will be required, to cleanse the mouth of the detached material and the increased secretions; and, in general, the completion of the process will occupy more than one sitting. Since this deposit often extends beneath the free margin of the gum, much care is necessary to see that it is all removed.

GREEN TARTAR.

This deposit has been so referred to by writers, as to convey the impression that it is of the same generic character as salivary calculus. Such a misapprehension is hardly pardonable. The teeth of

young persons only are subject to this affection, it being often found on those of children three or four years old; appears on the labial surfaces of the superior front teeth, and in largest quantity near the margin of the gum. It is seldom seen on the inferior teeth, and only on the anterior surfaces of the superior. The color of this deposit varies from a light brown to very dark, inclining to green. Wherever present, the surfaces of the teeth are abraded, and when it is of long standing, the entire enamel beneath it is destroyed, and the dentine is gradually involved in the dissolution. This effect upon the teeth is not produced by the coloring matter observed upon them, but by an acid in combination with this material before it is deposited. The stain is a precipitate from this compound, and the acid, leaving this, combines with the calcareous ingredients of the teeth, to their detriment as above; but the precipitate is entirely innocent, so far as decomposition of the teeth is concerned.

Its Origin.—Green tartar, or green stain, doubtless has its origin in the mucus, when this is in a particularly acid condition. That it does not proceed from the saliva, is proved by the fact that it is never found where there is a free flow of saliva, or where it has free access; but the point of its deposit is where the saliva is least frequently present, being most

abundant in cases in which there is a large relative amount of mucus, and this in a very acid condition. But the query might arise here, if the mucus of the mouth were wholly in that condition, why would not the teeth suffer from it elsewhere? Because, on the masticating surfaces of the teeth, the friction of the food will prevent it, and on the inner surfaces, the friction of the tongue; besides, wherever there is a free flow of saliva, this will have a counteracting effect. Decay goes on very rapidly, after it has once commenced, upon teeth affected by this deposit.

There are points of dissimilarity between this *green pigment* or *stain* and salivary calculus, that it may be well to notice. The latter is from the saliva; the former from the mucus; and hence the one exists where there is an abundant flow of saliva, and the other where the relative quantity of this is small. The calculus is deposited when the saliva is in an alkaline condition; the stain, when the mucus is very acid. The former is deposited in large quantities and thick incrustations, and upon the surfaces of the teeth, and is easily removed without detriment to their substance; whereas the latter is a thin film, barely sufficient to stain the surface, and yet it enters into the tooth-substance itself, and cannot be removed without detaching some portion of the tooth with it. The one seems rather preventive of caries.

which does not occur beneath it; but the other is highly promotive of decay. With these marked features of difference, it is surprising that the two should ever have been confounded, since it is so important that the distinctive character of each be understood, in order to its correct treatment.

Treatment.—In order to a perfect and final remedy for green stain, therapeutic treatment must be combined with the operative; but only the latter will be here described, which has for its object the removal of the deposit, and the rendering of the eroded surface smooth and polished. There are two or three methods of accomplishing this object. When the erosion is but slight, it can be effected with Arkansas-stone, or pulverized pumice and water, applied with a wooden polisher of the proper form till the stain disappears, and with the subsequent use of the burnisher with a solution of soap. But when the erosion is too extensive to be thus reduced, it must be cut down with a file, and then finished with stone and burnished, as before. And when the erosion is extreme, a cutting-instrument may properly precede the file.

IRREGULARITY.

By this term we imply those variations from a beautiful and natural position in which the teeth are

so frequently found. The principal cause of irregularity is a disproportion between the size of the arch and the space required for the accommodation of the teeth. When this disproportion exists, the teeth which are first erupted occupy very nearly their proper position; but those which come afterward, are more or less disarranged, in proportion to the preoccupation of the space. There are cases in which the roots of the temporary teeth are not absorbed, and the permanent teeth are erupted out of their true position, even when there is room enough for them were the former removed. Irregularity is mainly confined to the front teeth, and consists in either an inward or an outward inclination, and in some instances both. Sometimes the incisors are turned round in the socket, so that the edge stands at a very considerable angle with the proper position.

The upper teeth are oftener materially disarranged than the lower, though the latter frequently exhibit some irregularity in front, in consequence of a crowded condition. The teeth most liable to be out of position are the cuspidate. These, of the teeth of replacement, are the last in their eruption; and it often occurs that the arch is previously well-nigh occupied, in which case they are thrown outward. When there is any irregularity of the bicuspids, it is usually that of an inward inclination. The first and second molars are

very seldom out of proper position. The third molars, however, for want of room, are sometimes thrown out toward the cheek, or even prevented from coming out at all in any direction.

Effects.—In all cases, irregularity is favorable to decay. It is even maintained by some that the organic structure of irregular teeth is less perfect than that of regular, because the former are impeded in their eruption, and thus impaired. But this, to say the least, is questionable; for it will be remembered that the crowns of the teeth are formed and ossified before they can be much affected by a crowded state; and it is hardly probable that they could be materially modified in their structure after this period. The crowns of the teeth are rarely if ever deformed by a crowded condition. The principal cause of the liability of irregular teeth to decay, is the facility they furnish for the lodgment of foreign substances about them, and the difficulty they present to its removal. And, again, in irregular teeth, parts are approximated that nature did not intend should be brought together. Irregularity impairs the speech, impedes the mastication, and often distorts the countenance and deforms the features.

ATROPHY.

This affection is characterized by defective spots in the enamel,—white, chalk-like,—which scarcely ever penetrate the dentine. In these spots there is little or nothing of that organic structure exhibited by well-formed enamel. They are usually small, but vary greatly in number. They are often found arranged in transverse rows across the tooth affected. The superior incisors are most frequently affected with atrophy, though the bicuspids and molars sometimes exhibit it. The front upper teeth are attacked by it only on the anterior surfaces.

Instead of the spots, sometimes pits or indentations into or through the enamel are found, which occasionally run together, so as ultimately to form transverse grooves of considerable extent upon the teeth. In many cases, where on the eruption of the teeth the spots only are presented, the organs are not injured, except in appearance, the spots retaining the smooth, enamel-like surface during life. In other cases, the spot is of such a soft, friable texture, that it early crumbles out, leaving the pits above referred to. These indentations, however, sometimes exist at the first appearance of the tooth, but more frequently afterward, being formed by the disintegration of the defective portion.

Atrophy usually occurs on teeth of good structure, short, thick crowns, and rather yellowish color. The long, thin, white tooth, of imperfect organization and insufficient density, but seldom, if ever, presents an atrophied condition.

The Cause.—It may be difficult to point out the precise cause of this affection, but some facts in regard to it are very obvious. There is in every case an obstruction in the development of the enamel at the point of defect, and at the time of its organization. In some cases, doubtless, there is a deficient amount and an inferior quality of the materials elaborated for the upbuilding of the structure; and this is probably the case when the pits exist at the eruption of the teeth. In other cases, the requisite quantity of materials may be elaborated, and yet the vital energy be insufficient to organize it, as in the case of the spots referred to. The latter condition is more frequent than the former, as is evidenced by the more frequent appearance of the spots than of the pits. We are led to infer, then, that the origin of this affection is for the most part constitutional, and not local. There are commonly found traces of it on all the teeth whose enamel was in process of formation at the time of the interruption.

Any general disturbance, such as to interrupt the assimilative process, would be detrimental to the

perfect formation of the tooth. Again, some affections may materially affect the organizing power of the system without interfering with the assimilative power. Any disease that interrupts the functions of the digestive apparatus is prejudicial to the process of assimilation; whilst other diseases, such, for instance, as those of a febrile character, would diminish the vital power, and consequently the ability to build up organic structures, without interrupting in any special manner the process of assimilation. These things are referred to here for the purpose of showing under what circumstances atrophy of the teeth may occur.

Effects.—In the best formed teeth, there are no unpleasant results from atrophy other than its detraction from their beauty, and sometimes being the occasion of decay. The spots are unsightly, and when the pits are present, they become dark, and sometimes black, from deposit, which, by ordinary means, is difficult of removal. In teeth of inferior structure, decay often supervenes in these pits, and, extending thence, involves the other parts; and anything that will affect the tooth-substance, will find a beginning place in these spots.

EXOSTOSIS.

This term, critically defined, implies *outgrowth from a bone;* but, as applied to the bones generally, and particularly to the teeth, it probably conveys the idea of *growth upon the bone.* The affection thus denominated is common to all the bones; some, however, being more frequently attacked by it than others. It occurs upon the roots of the teeth, but is never developed where there is no periosteum. It is so nearly allied in structure and character to the cementum that covers the roots of the teeth, that it may be regarded as hypertrophy of that tissue. The manner of its accumulation is not uniform; but it commonly consists of an enlargement on the point of the root, or from the point some distance toward, and occasionally all the way to, the neck of the tooth. In some cases it extends entirely round the root, and in others is confined to one side. It sometimes results in such an enlargement of the root, especially if it is near the point, as to render the tooth very difficult of removal. When the root is bulb-form, its attachment may be broken up, so as to allow it to rotate in the socket, and yet be very difficult to remove; indeed, in some instances, impossible, without cutting away a portion of the process.

The density of the deposit does not vary much from the normal cementum of the root on which it is found, though in this respect there is sometimes slight variation; in a few instances we have found it softer than the root proper. The surrounding parts are absorbed for its accommodation. The color of the substance is slightly yellow, not differing much from that of the root itself; but sometimes it exhibits a semi-translucent appearance. The rate of its formation varies considerably, sometimes increasing so rapidly as to occasion difficulty, by impingement upon the surrounding structure, especially nerve branches, and at other times seeming to advance very slowly; and frequently it is arrested altogether. Roots are often found affected with exostosis that have been dead and crownless for a number of years, and yet have never, so far as known, given any trouble because of the affection. Teeth perfectly healthy in other respects may be thus affected.

Its Effects.—It always increases the difficulty of removing the tooth, either by enlargement of the point of the root or by deposit upon one side of it, causing it to curve; in which latter case the difficulty is all the greater, from the impossibility of determining the direction of the curve. It sometimes produces a diseased condition of the surrounding parts—in some instances chronic inflammation—that

may continue as long as the tooth remains. Nervous affections often result from exostosis, either through irritation, caused by pressure on the pulp, or through the diseased condition of the surrounding parts. The floor of the antrum is sometimes absorbed away, in consequence of the enlargement of the point of the root; and then disease of the lining membrane of that cavity may occur.

The Cause.—The cause of this affection is not well understood; though much light has been thrown upon it by the researches upon the reproduction of bone, and especially so far as the function of the periosteum is concerned. It is most probably deposited by the periosteum when this is in an abnormal condition; but what peculiar condition, it is not clearly ascertained, though some have supposed it to be inflammation. It is patent, however, that something more than a state of simple inflammation exists; for there is inflammation in numerous instances without this deposit. Again, in all cases where there is periostitis, that state is definitely indicated by percussion upon the affected tooth; indeed, in the occlusion of the jaws, pain is usually experienced. Yet there are found many teeth whose roots are subjects of this deposit, that have never given any indications, either by pain or otherwise, of a diseased condition.

This subject is one in which there is room, at least so far as dentists are concerned, for more extensive observation.

DENUDING.

This consists in a wasting away of the enamel of the anterior teeth, from the points toward the necks. The affection, however, is of too rare occurrence to demand extended consideration. The color of the enamel is not changed by this process, nor is its natural polish impaired by any abrasion. The dentine, on becoming exposed by this removal of its natural protection or covering, is perfectly smooth, but of a yellowish cast, in some cases inclining to brown. When the enamel is removed, there seems to be a cessation of the destructive process; for the crowns of such teeth will, in many instances, endure for a long time—indeed, till they are worn down by the friction in mastication.

This wasting process usually begins at the points of the teeth, and proceeds toward the necks, on all sides, till the enamel is entirely destroyed. Sometimes, however, it commences on their labial surfaces; this is particularly the case with the superior anterior, but very seldom with the inferior teeth. The affection, however, attacks the inferior more frequently than

the superior teeth; yet it is found assailing both with about equal energy.

The cause of this affection is not well understood, though it is generally conceded to be by the operation of an acid contained in the mucus; and this, with but little doubt, is the source of the agent; for the destructive process usually occurs where there is a large relative amount of this secretion; but that it is an agent of a very decided acid character, we are not prepared to affirm. Decay of the teeth does not seem to progress with greater rapidity while this affection exists than at other times; and again, the enamel does not present the roughened, abraded appearance resulting from the operation of any ordinary agent. With these apparently incongruous facts, it is rather difficult to arrive at a definite conclusion as to the precise manner in which this condition is produced, or the exact character of the agent instrumental in its production.

CHEMICAL ABRASION.

This consists in a gradual destruction of the entire substance of the crown of the tooth—the enamel and the dentine. It is an affection of comparatively rare occurrence. It attacks the superior more often than the inferior teeth, though both are subject to it. It

begins upon the points of the central incisors, wasting them away more rapidly at the median line, from which it progresses each way, involving the lateral incisors, cuspids, and sometimes the bicuspids, so that a curved line is presented by the edges of the teeth, of greater or less inclination, according to the rapidity of the process. When the superior teeth only are affected, the opening between the ends of the upper and of the lower front teeth, when closed, is a semi-ellipsis. If the inferior teeth are affected, as is sometimes the case, then the opening will be an ellipsis.

In the case of Mr. G., the affection had been progressing about two years and a half; the wasting away extended to the first bicuspids both above and below; and when the jaws were closed, the ends of the upper and of the lower central teeth were about one-third of an inch asunder, and the opening was of the elliptical form. It was a mystery to him. Two years and a half before, his anterior teeth shut close together on the ends. He had not used them in the mastication of his food, for his molar teeth were all good, and sufficient for this purpose; and, moreover, it had been impossible for him to use them in mastication, since he could not bring them together; and he had not been in the habit of putting any hard substance between them.

The Cause.—The cause of this affection, like that

of denuding, is not well understood. It is supposed, however, to be induced by an acid contained in the mucus. If this supposition is correct, it must be some acid with whose nature we are but little, if at all, acquainted; or, if any ordinary acid, it certainly must be modified by very peculiar circumstances, so that it effects a solution of both the animal and the earthy constituents. The surface upon which it acts is always perfectly smooth and polished, never presenting that roughened and abraded appearance caused by the action of any ordinary acid upon enamel or dentine. And again, if this affection results from the operation of an acid in the mucus, why does not this acid, to some extent at least, affect the teeth at other points? Such is not the fact; and caries that has previously commenced at other points on the teeth, does not progress more rapidly during the existence of this disease than before; but it certainly would if there were a large quantity of acid in the mucus.

It has been supposed that the mucous follicles of that part of the tongue which comes in contact with the teeth at the affected part, are the agents that produce the disease. Of this, however, there is not evidence sufficient to warrant an adoption of the theory. The cupping of the molars and bicuspids bears strong indications of being an analogous process, and yet no such influence can there operate for its

accomplishment. We have no theory on this subject to present, regarding it as still an open field for investigation. There can be little doubt, however, that the cause of denuding, of chemical abrasion, and of cupping, has its origin in the constitution, is not merely local, and may be removed, and the affection arrested, chiefly by constitutional treatment.

NECROSIS OF THE TEETH.

By this term is understood the death of the part affected. It has been remarked that the condition is similar to mortification in the soft parts of the system. But in the latter there occurs a change of structure; whereas, in the bones, and particularly in the teeth, there is not necessarily any immediate structural change consequent on the loss of vitality. The teeth have their organic connection with the surrounding parts by the external and the internal periosteum and the pulp; their crowns depend chiefly for vitality upon the internal organism, as is evident from the total loss of sensibility in them immediately after the destruction of the pulp.

Necrosis of the teeth differs from that of the other bones in some particulars, one of the most obvious of which is, that in the former there is no exfoliation, the living structure not having the power to throw

off the dead or necrosed portion. Again, a dead part in contact with the living does not materially affect it. The roots of the teeth depending for their vitality upon both their internal and their external connections, the former of these connections may be destroyed without materially affecting the latter. Thus, a tooth may be partially necrosed,—that is, vital in one part and dead in another,—without immediate injury to the living portion, and without separation of the living from the dead. It is a happy provision that the analogy between the teeth and the other bones does not, in this respect, obtain; for if it did, we should find the crowns of the teeth separated from the roots in all cases, immediately after the death of the pulp.

There results but little change of color to the teeth from necrosis, unless coloring matter is absorbed by the dentine from the decomposed pulp; though of course the lifelike lustre and appearance of the living teeth are not present. Total necrosis destroys the entire organic connection of the teeth with the surrounding parts, in which case they are very soon expelled from their sockets as useless.

Causes.—Caries is a very common cause of necrosis, especially the partial form of it to which reference is made above. Protracted fever, or diseases of any kind that diminish the vitality of the

constitution, will in a corresponding degree diminish that of the teeth, and sometimes destroy it entirely. Excessive medication, especially with mercurials, will sometimes produce partial, and occasionally total, necrosis, as will also sometimes blows or violent shocks, when these are not sufficient to displace the teeth. Sudden and extreme thermal changes have been reckoned causes of this affection; but it may well be doubted whether they are adequate, without the concurrence of other influences.

CHAPTER II.

CARIES OF THE TEETH.

Notwithstanding the teeth are so important in the human economy, having functions so various and so extensive to perform, they are greatly neglected in most instances, and in many subjected to positive violence; as, for example, in crushing or biting hard substances, sustaining weights, and suffering severe blows, sudden extremes of temperature, bungling dental operations, etc. Very few give that attention to these organs which is requisite to preserve them from injurious influences; and, owing to artificial modes of life, and consequent impairment of health, this is often difficult to do. Indeed, these influences are frequently not known, and the causes of disease in the teeth not explored.

Such is the truth, to some extent, in regard to caries; though this affection is more generally a result of conditions well understood. The dentine is affected more frequently by caries than by any other form of disease. It is both frequent in occurrence and fatal in tendency. Scarcely any that

have attained maturity are exempt from its ravages. It is a disease which the vital forces, owing to the nature of the tissue, can but feebly withstand, at least with far less efficiency than in more highly organized structures; and the restorative process is wholly inoperative here. Some maintain that softened dentine does in many cases regain its normal density; but this cannot be, unless it retains its vitality. But any agent possessed of sufficient energy to decompose the dentine, will destroy its vitality; yet a partial removal of lime salts is not always incompatible with, or destructive to, vitality; in such cases the normal density of the affected part may be fully restored; and even increased growth has in a few instances been observed. In decay, there is a lack of vital power to maintain the integrity of the organic structure, or there is the action of some agent having an affinity for a certain part of the dentine more potent than that vital power. In either case, the vitality is destroyed. In an organized structure, removal of one of its essential constituents occasions a loss of vitality.

Caries usually makes its first attack upon the dentine, and progresses most rapidly in the direction of the tubuli. There are variations from this course; as, for example, in the large superficial caries on the labial surfaces of the superior incisors. In many

cases, too, it advances immediately beneath the enamel. Portions of the dentine imperfectly protected by the enamel, on account either of an injured condition or of an imperfect formation of the latter, are liable to be attacked by this disease; and points that, by their location or any other unfavorable circumstance, retain injurious agents in contact with the tooth, are very subject to decay.

The attack and progress of caries are modified by the constitution of the teeth. These may be defective, either originally or accidentally. Original defectiveness extends to all the teeth of the same individual, whilst accidental exists only as to some of the teeth in the same mouth, and these only at particular points. Such conditions are peculiarly favorable for the attack of caries. When the whole crown of the tooth is imperfectly organized, the decay will advance with uniform rapidity, under the influence of uniformly persistent agents, till the whole is destroyed. But when it is only a portion of the tooth, the caries after a time becomes retarded in its progress, and in some cases checked altogether.

Among the circumstances which modify the progress of this disease, are, a change of the condition or character of the agencies producing it, and an increase or diminution of the amount of such agencies. The progress of caries will also be governed

somewhat by the age of the person whose teeth it attacks, as well as by the peculiar constitution of the organs themselves; for, in regard to constitution, they present an almost infinite variety, the relative proportions of their constituents being exceedingly various, even in persons of the same age, and continually varying in the same person at different ages. There is a constant change going on, the calcareous elements usually increasing, and the animal decreasing. But a proper relative amount of elements may be elaborated, and yet a defective organization exist. This condition arises from defective organizing power, or from a failure in arrangement and combination of the materials, and is dependent entirely on accidental causes. In vital energy, indeed, the teeth exhibit great diversity; and this corresponds with, and to some extent depends upon, the vital energy of the general constitution. Dead dentine is decomposed more readily than living; and hence the conclusion that vitality resists caries, and that this resistance corresponds with the vigor of the vitality.

The points most frequently attacked by caries are the proximal surfaces of the teeth, the indentations and fissures on the masticating surfaces of the molars and bicuspids, the longitudinal depressions on the buccal and palatal walls of the molars, and the necks of the teeth at the termination of the enamel. On

the proximal surfaces, the enamel is thinner than elsewhere; and the situation is peculiarly favorable for the accumulation and retention of injurious agents. The union of the enamel in the fissures and indentations of the crowns of the molars is often imperfect; and thus there is a way of entrance for vitiated fluids to the dentine. Decay is found at the terminations or intersections of these fissures earlier than at any intermediate points. The indentations, or grooves, on the sides of the teeth are usually attacked by caries at that point next to the neck. Less frequently, the disorder is exhibited at the neck, just beneath the border of the enamel, under which it burrows with a transverse extension.

The order in which the elements are removed is governed by the nature of the agent which effects the decomposition; and this is usually one having an affinity for the calcareous elements strong enough to destroy the texture of the dentine, and remove the earthy portion. Those acids which have an affinity for the lime of the dentine, produce its decomposition in this manner. When the decay is thus caused, the portion remaining in the cavity is soft, and approximates the gelatinous condition as the calcareous material is abstracted. Agents of a different character, too, often produce decay. Alkalies will act upon the animal portion of the dentine,

and remove it; and in caries thus produced, the residue is friable and chalk-like.

In other cases the constituents are simultaneously removed. Nitric acid will cause an entire breaking-up of both the earthy and the animal constituents.

The dentine outside of the decay may be in an inflamed and irritable condition, so that the contact of an instrument with the decayed portion will produce pain: and thus we may be led falsely to conclude that the softened dentine is sensitive; and, indeed, it is maintained that in some cases the partially decomposed dentine is so, on the supposition that a small portion of the calcareous elements may be removed, and yet the vitality of the part not be destroyed.

The progress of caries is far more rapid in the crowns of the teeth than in the roots, for the reason that the former are more exposed to the influences of external injuries. It is true that the crowns are covered by enamel, which is designed to shield the dentine from injury; but this is often defective, and on it are accumulated agents that it cannot resist even when it is perfect, so that the enamel itself is sometimes decomposed. The roots, too, possess a higher degree of vitality than the crowns, and their ability to resist the encroachments of decay is correspondingly greater; and hence we

often find the roots of teeth solid and free from decay, the crowns of which have been removed by rapid decomposition. Injurious substances are sometimes pressed into contact with the dentine through defects in the enamel, or under its projections, and there retained till their mischievous effect is produced.

It is maintained by some writers that caries is contagious. Dr. Koecker was of this opinion. The question, then, is, whether there is any property in the decayed dentine of one tooth capable of producing the same condition in the healthy dentine of another? The residue of abnormal dentine in the soft decay consists of the animal elements and a small portion of earthy material; and in decay in which the gelatinous constituent is abstracted, the remainder is chalk-like, consisting mainly of phosphate of lime. In neither of these is there anything that can possibly operate on the healthy dentine. There is one thing here, however, that is worthy of remark, and that has perhaps led to the mistaken notion that caries is contagious: decayed dentine will absorb and retain fluids that injuriously affect sound dentine; and when the decay is on the proximal portion, two teeth are subject to the same exciting cause. But it is seldom that two teeth thus situated are both in the same stage of decay—

a fact principally attributable to the difference in their constitution. The decay of the teeth in pairs has also been adduced as evidence of the contagious character of the disease. This, however, results from the fact that the pairs are formed at the same time, are subject to the same influences in their formation, and hence are constituted alike; and if one of the pair is defective, the other will probably be in a like condition. When there is a vitiation of the saliva or mucus, they will be similarly affected. In no common acceptation of the term contagious can it be applied to caries of the teeth.

The color of caries is exceedingly various, from that of healthy dentine, through every intermediate shade, to jet black. The rate of the progress is indicated by the color of the decay, being slower as this is darker, so that when the decay becomes almost stationary, the affected portion is usually black. The degrees of color are differently enumerated by different writers; as, by Koecker five, by others seven, and so on. Three, however, are sufficient for our purpose: white, brown, and black. The sensitiveness of the dentine is greatest in teeth affected by the white decay, and usually decreases as the color darkens; though there are exceptions to this rule, for occasionally the teeth affected by dark decay are quite sensitive. The light-colored decay is more difficult to arrest than the

dark. In many cases of the former, filling seems hardly to retard its progress; whereas in the latter, by proper filling, the advance of the decay may be checked altogether. The cause of the dark color of caries is not perfectly understood, but is probably owing to the carbonization of the animal portion.

The opinion is entertained by some that this dark material protects the dentine from the influence of injurious agents. But this is most probably not correct, at least to any perceivable extent. If it does thus serve as a protection, its removal would subject the dentine to a renewed attack of caries, which experience assures us it does not do. Those who maintain this opinion, refer, in support of it, to the fact that when a deposit of oxyd of silver is made upon a decay of light color, by the use of nitrate of silver, the progress of the decay is thereby retarded. This retardal, however, is effected more probably by a change in the character of the decay than by any protection afforded by the coating of oxyd of silver.

Some sensitiveness commonly accompanies caries. It does not often amount to pain, but is rather a sense of uneasiness; yet from change of temperature, or contact of acids or hard substances, intense pain may be produced. Dr. Koecker remarks that caries is most tender in its first stages; and Dr. Cone that when a tooth is attacked by it, the sensitiveness is

increased. The surface of the dentine, or that part united to the enamel, is susceptible of the most acute sensitiveness. When there is inflammation of the dentine, intense pain may be produced by the contact of an instrument, in a cavity of decay, at the line of union of the dentine with the enamel, with very little sensitiveness present elsewhere in the cavity. Sensitiveness of a uniform character sometimes pervades all parts of the cavity, while at other times it may be very intense at one point, and very slight or entirely absent at any other. A thin lamina of the dentine lining the whole cavity may be uniformly sensitive, and in some cases sensitiveness involves the entire body of the dentine.

By means of this sensitiveness, warning is transmitted to the pulp, which emits osseous material with increased energy; and thus a process of filling up the natural cavity of the tooth is instituted, that the decay may not encroach upon the pulp. But this warning may in some degree be transmitted to the pulp though there be no appreciable increase of sensitiveness.

This sensitiveness is modified by the character of the teeth, the nature of the decay, and the state of the patient's constitution. The teeth of the same person will be more sensitive at one time than at another, because of a greater irritability of the nervous

system. Those teeth which decay most rapidly are usually most sensitive; though in teeth whose vitality is lost considerably in advance of their decay, there is no perceptible sensitiveness at all. Except in such cases as last mentioned, the whitest and most rapid decay has most sensitiveness, the brown much less, and the black scarcely any.

PREDISPOSING CAUSES OF CARIES.

The causes of caries of the teeth may be considered under two general divisions—predisposing and exciting. Of the former some are original, others accidental. The original development of the constitution may be defective, either from original or from accidental defect in the parent, but more certainly from the former. Constitutional characteristics are transmissible, and a defect is as surely hereditary as anything else. In the fetus, during gestation, germs may have originated from which perfect organs can never be developed, and these germs may be more or less defective according to the constitutional condition of the mother, or according to accidental conditions to which she may be subject, and which may seriously affect the fetus. After birth, too, the child is exposed to injurious impressions, which will, to a greater or less degree, render the development defective; as

imperfect nourishment and the diseases and functional derangements peculiar to childhood. A diseased condition, or functional derangement, will interrupt the proper elimination and perfect upbuilding of the materials necessary for the perfect structure; and indeed anything that will disturb the equilibrium of action in the system may be detrimental to the teeth.

In some instances the teeth will exhibit the peculiarities of the mother, and in others those of the father, while sometimes they simulate those of both parents; and when the parental imprint is thus found stamped on the teeth, it will also be found that those of the same class decay at the same points and at about the same age as in the parent. In such cases the defect is manifestly hereditary; it cannot be accidental: the coincidences thus constantly occurring preclude any other conclusion. Hereditary taint, then, may be regarded as a predisposing cause of caries.

Impaired vitality is another predisposing cause; and not only impaired vitality of the teeth and contiguous parts, but also that of the general system. Indeed, the vital vigor of the teeth depends upon that of the general system, and, when there is no local adverse influence at work, corresponds with it; so that when the general system is in the most

healthy condition, the teeth possess the greatest power of resistance to deleterious agencies. This resisting power is, at best, comparatively feeble; but its feebleness is to some extent compensated by the peculiar structure of the teeth, which are less liable to decomposition than any other part of the human body. Yet the integrity of these organs depends much on the maintenance of a healthy vitality, and this on that of the general system. A dead tooth will decay far more rapidly than a living one in similar circumstances; and hence the conclusion that vitality resists injurious agents, and that the resistance will be in proportion to the vitality.

All febrile conditions promote and facilitate decay, and frequently in two ways: by diminishing vitality, and by changing the secretions of the mouth so that these act injuriously upon the teeth. Accompanying such conditions there is generally inflammation of the dentine; and in such cases this always partakes of the general disorder, so as to become very susceptible to injury. All diseases, indeed, that impair the vitality and change the secretions, may be considered predisposing causes of decay, and some even more; dyspepsia, for instance, being not only predisposing, but also exciting, since it prepares in the stomach an acid that is almost continually thrown upon the teeth, and that acts upon them with great energy. Resi-

dence in miasmatic regions is also a predisposing cause, inducing unfavorable conditions.

Diminished vitality may result either from constitutional or from local causes. These latter are such as produce an irritable or diseased condition of the contiguous parts, or an abnormal condition of the dentine, without the power to effect its decomposition. Local causes of a diminution of vitality are not in their character so formidable, and not so difficult to control, as those which are constitutional.

Many medicinal agents are regarded as predisposing causes of caries; and among these, mercurials occupy a prominent place. They operate by vitiating the secretions of the mouth, and producing an abnormal condition of the periosteum about the roots of teeth, the mucous follicles, and the salivary glands. Some entertain the opinion that the abnormal action of the absorbents induced by mercurials predisposes to decay.

Dental operations performed at an improper time, and in an improper manner, may be reckoned among the predisposing causes of caries. The vitality of the teeth may be thus impaired, or a diseased condition established, or the part operated upon may be permitted to remain rough, so that foreign substances will be retained, and, becoming vitiated, produce a deleterious effect. Often, from an improper use of

the file, extensive inflammation of the dentine supervenes, which is sometimes followed by death of the tooth, and by disease of the contiguous parts. Artificial substitutes, imperfectly adapted, are in many instances the occasion of caries; not that clasps or the edges of the plate tend directly to injure the tooth, but the agencies superinduced by them do, and especially when the material used is not of the right quality.

Lack of proper exercise in mastication induces a condition favorable to decay, both by favoring the action of injurious agents upon the teeth and by withholding the stimulus of normal exercise. Tartar and other deleterious substances are much more rapidly deposited when the teeth are idle.

The teeth cannot with impunity undergo great and sudden transitions of temperature, or even such variations as may be endured by the surrounding parts. By these, inflammation of the dentine may be induced, and the vitality of the teeth diminished. And in friable teeth, checking of the enamel may occur, and thus a condition arise that will facilitate decay.

EXCITING CAUSES OF CARIES.

When there is a predisposition to caries, any of the exciting causes act with more effect. Well-organized teeth, of unimpaired health and vitality, withstand influences that in less favorable circumstances destroy them in a very short time. The immediate cause of decay is the action of agents chemically upon the teeth. It is not here proposed to enter upon an investigation of the manner in which these various agents operate, for that would open up a large field for consideration—a field outside of the province of this work. The sources of these, however, are several: as, vitiated secretions of the mouth; the saliva, and the mucus; abnormal secretion from the stomach; decomposition of animal and vegetable substances in the mouth, etc.

The natural state of the mucus is acid, but that of the saliva alkaline; so that these secretions counteract each other; but when the saliva and the mucus are both acid, the teeth must suffer. These secretions may become vitiated through inability of the glands, from disease or an enfeebled condition, perfectly to perform their functions; or the blood may be in an abnormal state, and the glands unable, on that account, though they were healthy,—as they seldom are in such case,—to elaborate healthy saliva.

When the fountain is corrupt, the stream cannot be pure. Thus, anything that produces a diseased condition of the blood tends to the decay of the teeth; and such diseased condition often has a directly injurious effect on the secretive apparatus, and so works a double harm.

But to the theory of the pernicious influence of the saliva, it may be objected, that if it were true, all parts of the teeth would be alike affected. This objection, however, will lose its force when it is considered that the teeth, in many cases, are not equally well organized in all their parts; that some parts are not so well protected as others; and that between the teeth there is room for the retention of saliva and foreign substances, which there combine their influence upon them. When there is a great quantity of viscid saliva constantly flowing, the teeth decay very rapidly. The decay is of a light color—so light, indeed, that in many instances it is difficult to distinguish it, by this, from undecomposed dentine.

The gastric fluid often becomes deranged by irritation or disease of the stomach, so that the function of the latter is very imperfectly performed, and fermentation of the food occurs, evolving agents that injuriously affect the teeth. In dyspepsia, such agents are often brought in contact with the teeth by eructation and vomiting; and the diseased gastric

fluid, which contains a large proportion of hydrochloric acid, is also thus brought in contact with them, acting with great violence. After food commingled with this secretion is ejected from the stomach, the teeth will be found eroded over all their surfaces. Dyspeptics will appreciate this remark. In such cases, if the teeth are not of superior organization, they are destroyed in a short time. Their surfaces, thus roughened, afford a lodgment for foreign substances on all parts.

The most common agents, however, that injure the teeth, are originated in the mouth by the decomposition of animal and vegetable matter. By this process, elements are eliminated that form new combinations, and these operate with energy in the destruction of the teeth. Favorable conditions exist in the mouth for such decomposition, and also for such new combinations; for there is a sufficient amount of heat and moisture,—for both of these, especially the former, facilitate the action of any acid upon the dentine. The character of the saliva and mucus will very much modify the decomposition of foreign substances in the mouth. If these secretions are both acid, the decomposition will be much more rapid, and more potent in its effect.

Again, it is sometimes the case that the salivary glands are comparatively inactive, except when spe-

cially excited, and yet the mucous glands still efficient, eliminating their secretion; so that the mouth assumes an acid condition, because there is not saliva sufficient to neutralize the mucus, in which condition decomposition of foreign substances would be greatly accelerated. There are many cases, however, in which the flow of saliva is copious, and yet the decay very rapid, which is in consequence of an acid condition of both secretions, or of a rapid decomposition of foreign substances in the mouth.

There are acids taken with the food that act directly upon the teeth; as acetic acid, or vinegar. Professor Westcot says: "Acetic and citric acids so corroded the enamel in forty-eight hours, that much of it was easily removed with the finger-nail." And "Malic acid, or the acid of apples, in its concentrated state, also acts promptly upon the teeth." Now, these acids, in the use of many kinds of food, are brought into frequent contact with the teeth. In the manufacture of vinegar, sulphuric acid is often employed; so that in this article of food we have that acid either alone or combined with the acetic, the former acting with greater energy upon the teeth than the latter. Acetic acid also facilitates the fermentation of food retained in the mouth, and thus reproduces itself in abundance.

After eating apples that contain a great amount of

malic acid, the teeth will be found corroded over all their surfaces. This acid, as well as the others, affects the enamel somewhat, and when the latter is very thin, though it may not be all removed from any particular point, yet its integrity will be destroyed, so as to be readily fractured, thus admitting injurious agents to contact with the dentine, which is much more susceptible of injury from acids than the enamel: points imperfectly protected by this are violently attacked by acetic, malic, and sulphuric acids, especially when in the nascent state. In decayed cavities these agents produce rapid results. They should be as much as possible avoided, and, when necessarily used, should be removed from the teeth by cleaning with great care. It would be safest to employ some neutralizing agent after the use of any acids with food. During mastication, there is an increased secretion of saliva, which, if in a healthy state, will tend to neutralize any acid that may at the time be present, and also, by its flow, to remove foreign substances from the mouth.

Salts may be decomposed in the mouth, and their acids act upon the teeth; as when the acid of the salt has a stronger affinity for any element of the tooth-bone than for the base with which it is combined. Many medical preparations contain agents peculiarly deleterious to the teeth, acids being espe-

cially in requisition for these, and oftentimes in considerable quantities. The acids most commonly thus administered are the hydrochloric, the nitric, the sulphuric, the acetic, the tartaric, and the citric, any one of which will produce direct and rapid corrosion of the dentine, even when unaided by the temperature of the mouth. For a fuller and more explicit presentation of the points here briefly hinted at, see Appendix at the close of this volume, Sec. A. These acids are often administered by physicians without any regard to their nature or their influence upon the teeth. Sometimes, however, they are given through a tube, though this method generally does not amount to much as a precautionary measure, for in most instances the fluid comes in contact with all parts of the mouth. A subsequent rinsing of the mouth with water effects only a dilution, not an entire removal of the acid. In order wholly to counteract their injurious influence upon the teeth, an alkaline solution should be used after the administration of such medicines.

Galvanic action is a cause of decay of the teeth, only so far as it is a means of decomposing compounds in the mouth, and the elements of which, according to the laws of affinity, form other compounds prejudicial to the teeth. The elements hydrogen, nitrogen, and oxygen, may thus be set

free from animal and vegetable substances, when they will at once seek other elements with which to combine; and the character of the combinations will be determined by the nature of the elements, and by the attendant circumstances. These compounds will frequently be of an acid character.

Such an arrangement may exist as will maintain a constant galvanic action, whose legitimate effects will be as constant upon the teeth; and this ceaseless process cannot but make its mark. It is a favorable arrangement for galvanic action when there are two or three kinds of metals in the mouth at once, particularly if these are such as differ in their affinities for oxygen, and in their electric conditions. In some cases three or four kinds of metals are employed in filling teeth of the same mouth; in some, fillings of one metal and a plate of another; and in others, plates of so low a carat are used that they oxydize rapidly in the mouth, without the aid of any other metal.

COMPARATIVE LIABILITY TO DECAY.

All classes of teeth are not alike liable to decay. Their difference in this respect may arise from a dissimilarity in their organic structure, the best organized being the most capable of resisting disease; or from

a concentration of the destructive agency upon the tooth first affected. The first molars are much more liable to decay than any other teeth, since they are less perfectly developed than those formed at a later period of life. They are the first permanent teeth erupted, and are subjected to all the irritating conditions consequent on the removal of the temporary and the development and eruption of the permanent teeth. But these conditions in many cases produce no apparent injury upon them, they maintaining their integrity till all the other permanent teeth appear, and then decaying earlier than any others. In such cases, the decay is a result of influences more potent than those occurring on the eruption of the other teeth.

After the first, the second molars are most subject to caries; and after these the second bicuspids. The latter two classes doubtless are so subject, more from the facility they afford to the lodgment of deleterious substances than from a relatively imperfect organization. Besides, from six to fifteen years of age, the teeth are less appreciated and less cared for than at a later period of life. The next most liable to decay are the third molars. Then follow in order the first bicuspids, the lateral incisors, the central incisors, and the cuspids. Herewith are appended, in tabular form, one thousand cases of decayed teeth, as observed

under ordinary circumstances, exhibiting the number and per cent. of these in each class :—

26, or	$2\frac{1}{2}$	per cent.,	in central incisors.
28, or	$3\frac{2}{3}$	"	in lateral incisors.
24, or	$2\frac{1}{4}$	"	in canines.
87, or	$8\frac{2}{3}$	"	in first bicuspids.
134, or	$13\frac{1}{3}$	"	in second bicuspids.
370, or	37	"	in first molars.
218, or	$22\frac{2}{3}$	"	in second molars.
102, or	$10\frac{1}{3}$	"	in third molars.

Of these, a large proportion were removed for relief from disease originating in caries of the dental tissue. In general, the superior teeth are liable to decay earlier and more rapidly than the inferior.

CONSEQUENCES OF CARIES.

It is here proposed to refer only to some of the more common results of this affection, one of the most obvious of which is the exposure of the pulp of the tooth, on which exposure disease ensues, and finally death. During this diseased condition of the pulp, there occurs that very peculiar and well-known sensation commonly denominated toothache. As well as the destruction of the pulp, the entire destruction of the crown of the tooth is the inevitable consequence of caries, unless arrested in its progress. After the destruction of the pulp and the lining membrane,

the external periosteum in many cases becomes involved, the affection being but an extension of that which destroys the internal periosteum. Inflammation and suppuration are of common occurrence, by which a discharge is established from between the margin of the gum and the neck of the tooth, or through a fistulous opening in the process and the gum, as is the case when an abscess is formed at the point of a root.

A diseased condition of the alveolar process is in many instances produced by diseased and dead teeth, necrosis and exfoliation of considerable portions being sometimes the result. Indeed, extensive caries of the jaw is occasionally thus produced. Disease of the antrum, too, is very generally induced or greatly aggravated by the same cause. Tumors, sometimes of a malignant character, connected either with the bony or with the soft parts, not unfrequently spring from this source, particularly in constitutions of a cancerous diathesis. Great nervous derangement may result, either in whole or in part, from decayed teeth, as does very frequently facial neuralgia, which is sometimes confined to a single nerve-branch in the immediate vicinity of the irritating cause, sometimes ramified over the whole side of the face and head, and occasionally spreads much farther, so as even to implicate the shoulder and the arm. Neuralgia of

these, extending down to the hand, is often found to be instantly relieved by extraction of a diseased tooth; and any operator of much observation can call to mind numerous instances in which facial neuralgia has been thus relieved or wholly cured. This affection of the face, however, does not always originate in diseased teeth, though there is little doubt that in a majority of cases it arises wholly or partially from this cause.

Inflammation of the mucous membrane of the mouth is a common result of diseased teeth; and it is liable to extend to distant parts of this membrane, and occasion greater difficulty than in the mouth, as would especially be the case when there is an irritable condition of the throat and bronchia; and the esophagus and stomach are not exempt. In what degree such an implication of the respiratory and the digestive apparatus is referable to diseased teeth, it may not be easy to determine; but it is impossible that a number of such teeth, involving in their disease all the ramifications of the facial nerves and the whole mucous membrane of the mouth, could remain there with impunity. And besides this direct influence on the lungs and stomach, diseased teeth are constantly emitting offensive odors, which are taken in by inhalation, and offensive matter, which is swallowed with the food.

TREATMENT OF CARIES.

In the rational treatment of caries, the first considerations are the nature and peculiarities of the obvious predisposing causes; whether these are constitutional or local; and if constitutional, whether they are such as can be modified by therapeutic treatment of the general system. If the latter, such treatment should be adopted as will bring about the most perfect state of health, so as to obviate as far as possible all conditions favorable to decay, by securing a healthy condition of the mouth in all its parts—as the gums, the mucous membrane, and the salivary glands. The teeth should be kept free from all deposits and accumulations of whatever character; for though some of these may not affect the teeth directly, yet they induce disease of the surrounding parts, and thus indirectly exert a pernicious influence upon them.

The foregoing remarks, however, refer rather to the prevention of decay than to its treatment after it actually exists. Yet they are on that account none the less important, since here, as elsewhere, prevention is better than remedy. But they apply to such prevention as well after decay has commenced as before, if the ultimate object is preservation of the

teeth. After the first attack, the teeth are more vulnerable, and less capable of resistance.

When decay has attacked a tooth, the treatment indicated depends upon the nature and extent of the disease. Rapid decay requires more prompt and energetic treatment than that of slow progress. Remedies appropriate and efficient in the one are quite inapplicable to the other. The persistence of caries is not always in proportion to its rate of progress. We sometimes find teeth in which the decay is not advancing rapidly, and thence are led to conclude that it may be easily arrested; the affected part, if superficial, is easily removed, and the dentine thoroughly polished; and yet, after a time, decay again attacks the tooth at the same point. Or, where the caries has penetrated the tooth, so that it requires filling, though it is skillfully done, and the plug and tooth carefully polished, yet in many instances the dentine soon softens about the border of the filling.

The extent and nature of the decay will suggest the mode of treatment. Superficial caries on some parts of the teeth may be remedied and removed by cutting away the portion implicated in the disease, dressing with a fine file, polishing with Arkansas, Scotch, or rotten stone till the file marks disappear, and then applying the buff with rouge or oxyd of tin very thoroughly to the entire surface operated

upon. Afterward, the most careful attention to cleanliness is requisite, to prevent a recurrence of the attack. This treatment is applicable to decay upon proximal surfaces; but in the depressions of the masticatory and buccal surfaces of the molars, it is not practicable.

Sometimes the dentine, at points where it is exposed, gives warning, by acute sensitiveness, of threatened decomposition, before there are any other indications of it, thus evidencing the presence of some very irritating agent promotive of decay. Such points should receive prompt and strict attention, and the increased sensitiveness be immediately subdued; as it may be by the use of some preparation that will counteract the exciting influence—some dentifrice or lotion containing an alkali; or rubbing the sensitive surface with a steel burnisher will in many cases effect this object, and prevent the development of decay. Nitrate of silver is sometimes used for this purpose, and occasionally proves very efficient; but its general use for such cases is of doubtful propriety, and when used, it should be with discrimination and caution.

It has been suggested that the character of caries may be modified by the local application of therapeutic agents—that the rapid decay may be changed to the slow, and this, too, without regard

to the attendant circumstances, such as the condition of the secretions of the mouth, the causes producing the disease, etc. For this purpose various agents have been proposed. It is held that by an application of the nitrate of silver, the white, rapid decay being changed to that of a dark color, is arrested in its progress. But there is no very palpable principle on which this agent can be supposed to operate to arrest caries. It is generally conceded to be injurious to a healthy tooth; how, then, it becomes beneficial to one decayed, it is not easy to perceive. The notion may have originated in the fact that after the application of nitrate of silver, the dentine to which it has been applied turns dark, or black; and this color being naturally associated with the slow form of decay, it may have been concluded that it might be thus associated by artificial means. This conclusion, however, is fallacious; for the coloring matter being the oxyd of silver, deposited on the walls of the cavity, is wholly foreign, and holds no necessary relation to the kind of decay, or to the agent producing it. The deposit may possibly serve as a temporary shield to the dentine beneath, but only temporary; whereas, on the other hand, it will be remembered that nitric acid is liberated by the decomposition of the nitrate, and operates destructively upon the tooth-bone. An ethereal solution of

the terchloride of gold has also been suggested as a preventive application. Its operation would be much the same as that of the nitrate of silver, and equally inefficient. Preparations to neutralize and counteract the effects of deleterious agents upon the teeth have been recommended as topical applications. These are such as possess alkaline properties. But anything of this kind would require frequent application; indeed, it would be necessary to keep the affected part constantly under its influence, as long as the surrounding conditions continued to favor decay.

Though nothing of this kind can be relied upon permanently to arrest caries, yet, in many instances, much benefit is to be derived from local treatment. Alkaline topical applications will in many cases alleviate the most acute sensitiveness of the dentine, accomplishing this, no doubt, by their neutralizing influence upon the irritating agents. Many operators employ simply the bicarbonate of soda for this purpose, with the happiest results. As another class of topical applications to check or modify caries, those have been suggested which will form an insoluble compound with the gelatinous or animal portion of the tooth; such as tannin, creosote, and some of the essential oils. The only effect of these, however, is to form a shield or protection over the structure beneath: there is, of course, no change effected in the conditions or agents which produce decay.

CHAPTER III.

GENERAL REMARKS ON FILLING.

THE importance and value of the operation of filling teeth are obvious, from various considerations. It is one that is in frequent requisition. It is the only treatment for deep-seated caries. By it the disease is arrested and the lost part restored, so far, at least, as it can be by a foreign substance. There is no material similar to that destroyed—no substance possessing the characteristics of the lost portion of the tooth, with which to effect the restoration. Under favorable circumstances, the operation of filling is efficient in arresting caries, and restoring, to a greater or less extent, the lost portion of the tooth. In order, however, that it be permanent in its character, the case needs to be attended with favorable conditions, and the work to be thoroughly done. But two similar operations, both equally well performed, may result very differently as to ultimate success in preserving the teeth to which they may have been applied; the one effectually preventing further decay, and the other seeming to interpose to it but little

obstacle. Indeed, the probabilities of such success in different operations, equally well accomplished, cannot be calculated without considering a variety of circumstances, such as differences in constitutions, in states of health, in previous and subsequent habits.

Filling teeth is predicated upon the nature of decay, upon the fact that the lost portion will not be restored by nature, and upon the fact that caries is an effect of external causes, and not of any cause within the tooth itself. If the causes of caries were alone within the tooth, then filling would not be its rational treatment. The organic structure of the teeth is of such nature that no change to the extent of decomposition will take place in it independently of external influences. Any organ or structure susceptible of becoming diseased by any cause resident within it, usually possesses the power of recuperation, and, in many instances, that of restoration also; and if dentine could be decomposed without external agents, the introduction of any foreign substance whatever into the cavity would certainly not arrest the decay, but most probably accelerate it. If it is true that decay of the teeth ever originates in constitutional causes alone, then the treatment should be constitutional, and not local.

Filling teeth, then, is based upon the inability even of healthy dentine to prevent the occurrence of decay.

As preliminary to the operation, all the circumstances, both direct and collateral, should be carefully noted in every case, and the course of treatment should conform to the indications thus observed. The constitution, temperament, and health of the patient; the peculiarities of the teeth; their susceptibility of decay; their present condition, and that of the parts about them; the periosteum, the gums, the mucous membrane, the secretions of the mouth, the saliva, and the mucus, should all be closely considered; for only on a correct diagnosis can a proper treatment be based. Every operation should be performed as completely as, under the circumstances, it is possible. Indeed, every step in the operation should be perfect, before a succeeding one is attempted. All the instruments employed should be unexceptionable in material, form, and condition; inferior instruments should find no place in the case of the dental operator. The material for filling should be of the best quality, and prepared in the best possible manner. Not that material for filling should be prepared in only one way; for some materials, gold, for instance, may be prepared in three or four different forms, each perfect in its kind, and efficient in the hands of the expert manipulator. While with instruments and materials all in the most perfect condition, and with a thorough cognizance and appreciation of all the attendant cir-

cumstances, our most skillful operators barely attain success, need we be astonished that the man ignorant of all these circumstances, and possessed of only a few crude, ill-conditioned instruments and materials, the nature of which he does not understand, fails in almost every attempt?

Much depends on therapeutic treatment; not, indeed, to restore parts already lost, or to restore to health parts much diseased, but to avert a tendency to disease in parts but feebly organized. This treatment may be either constitutional or local, or both; but constitutional when there is indicated any idiosyncrasy favorable to decay. If, however, the whole difficulty is local, topical treatment only is required. What the special treatment should be in either case will be more fully considered hereafter. Comparatively little can be accomplished by local application to the substance of the tooth; but the parts contiguous, as the gums and the mucous membrane, may be thus treated, with an assurance of more signal results.

Though in the teeth nature does not assist to restore a lost portion, as in those parts more highly organized, yet, to compensate in some degree, the destructive process is far less rapid in the former than in the latter. The general surgeon depends much upon nature for the success of his operations; for, though he performed them unskillfully, yet the kind

energy of nature is always present to assist him; but in this specialty the practitioner must necessarily depend more upon his skill, and less upon the curative efforts of nature; though much more reliance is placed upon it now than formerly.

MATERIALS FOR FILLING.

In the selection of materials for filling teeth, there are some important considerations that should be kept constantly in view; the first and principal of which is to choose that kind which will protect the tooth from further decay—protect the affected part against the influence of those agencies on which the disease depends. A material or class of materials should be selected that would not, under any circumstances, induce either a local or a constitutional injury.

There are several properties that materials for filling teeth should possess, one of the most important of which is,

Indestructibility.—Any substance, whether simple or compound, that will not maintain its identity and integrity when subjected to any conditions of the mouth, is wholly unfit to be used as a material for filling. If compounds are employed, they should be such as would not be affected by the secretions of the

mouth, or by any attendant conditions. A mere mechanical mixture would not be an appropriate material for permanent filling; and all compounds of the metals, so far as we are familiar with them, are unfit for this purpose, by reason of the facility with which they are changed in the mouth. The next most important property of a material for filling is,

Adaptability.—By which is meant a capability of being wrought into suitable shapes for the purpose,—a facility of being applied and conformed to the parts upon which it is to be placed. There are substances that would be entirely indestructible in the mouth, and that would be very desirable in other respects as materials for filling, that are yet altogether worthless for this purpose, from lack of adaptability. Quartz, if it possessed this property, would be valuable as a material; but as yet there has been discovered no method of preparing it in an available form. On the other hand, many things possess the property of adaptability that are lacking in some other important particulars. The next important property is,

Hardness.—A material may possess all the other suitable qualities, and yet be too soft. A material should be hard enough not to be broken or worn away by any pressure or friction liable to be applied. This property is especially desirable for fillings in the

masticatory surfaces of the molars and bicuspids. It would, however, be admissible to employ a softer material for filling cavities in the proximal surfaces of the teeth, provided it would perfectly exclude all foreign substances.

Non-conductor.—Again, a material should be as nearly as possible a non-conductor of heat, particularly for filling sensitive teeth, or those liable to become so under the influence of slight causes. Great variations of temperature will in most instances aggravate sensitiveness, and, in susceptible cases, produce it; and if the irritation is continued, the result may be necrosis. Gold, which possesses the largest number of desirable qualities as a material for filling, is in this respect very defective, being one of the best conductors of heat. To obviate this defect, some non-conducting material may be employed between the gold and the sensitive portion of the tooth. The pulp is liable to be affected by sudden and great changes of temperature, transmitted to it through a gold plug.

Cohesion.—In the next place, a material should be susceptible of being welded or united into a solid mass. The permanency of an operation depends very much upon this quality. A filling having the different pieces which compose it perfectly united, will be much more durable than if effected with a material

in which this cohesive property is lacking, it can be made with greater facility, and will be better and longer retained; and mainly because such a filling cannot be destroyed piecemeal. Non-cohesive material is retained by the general form of the cavity, which is to be shaped so as to bind all the pieces together, and thus hold them in place; but a substance that will weld requires only two or three good retaining points, angles, or pits, properly situated, in order to be firmly and permanently fixed in a cavity of any form.

Color.—Another desirable property of material for filling is such a color as shall best harmonize with that of the teeth, particularly if they are in front. In this respect all the metals are objectionable, though gold is probably less so than any of the others, the objection to this being not so much in its color as in its luster; which objection, however, may be partially obviated by the kind of finish given to the work. In teeth of certain shades—semi-transparent bluish-white, for instance—gold, for exposed fillings, is very objectionable, indeed, in some cases, almost as unsightly as the absence of the tooth; and in such instances, the darker metals would of course appear much worse. For such teeth, some mineral substances, having more nearly the color of the teeth, would be the most desirable.

Most of the materials employed for filling are metallic; only a few non-metallic substances have been used, and these rather by way of experiment, and for temporary purposes, than with any hope of permanent results. Of the metals, gold possesses more of the indispensable properties than any other; but the following have been used for filling: lead, tin, silver, platinum, gold, and amalgam. In the preparation of the latter, gold, silver, platinum, tin, bismuth, antimony, cadium, zinc, and mercury, have been employed.

Lead.—This metal, in the early history of the profession, was used to some extent for filling teeth, though it possesses but few of the requisites for that purpose. The principal quality which recommended it is its adaptability; but it is quite too soft for permanent fillings in the masticating surfaces of the molars. It is easily wrought into foil and welded into mass in the cavity, but it is rapidly worn down by mastication, and its integrity readily impaired by the influence of some conditions of the mouth; much more readily, indeed, than that of tin or silver. Acetic and some other acids act upon it with considerable energy in the mouth. By exposure to air and moisture, it is soon coated with carbonate or protoxyd of lead; and this change is effected much more readily in the mouth. Lead is also objection-

able in color, especially for fillings in the anterior teeth, it being darker than the other metals employed for the purpose. It is, however, a less perfect conductor of heat than some others that are in far more extensive use.

Tin.—This metal has been, and is even yet, much employed as a material for filling. It is easily wrought into foil, and in that condition is readily adapted to the purpose, by reason of its softness and pliability. Fillings can be made with it in all cases in which non-cohesive gold foil can be used, to much of which, indeed, it can by skillful manipulation be made superior in cohesive property. Its quality, however, is greatly dependent on the manner of its manufacture. It is harder than lead, and in many cases hard enough for permanent fillings; it is frequently retained in crown cavities of the molars, effectually preserving the teeth for many years. In favorable conditions of the mouth, it is not materially changed, not oxydizing easily, and not readily uniting with any substances liable to be brought in contact with it. But in an unhealthy mouth, with the secretions in an abnormal condition, and the teeth neglected, tin fillings are very rapidly destroyed by the action of nitric or hydrochloric acid. Such a change may take place in the mouth as will in a little time destroy tin fillings that had long remained in good

preservation: and hence this material is not entirely reliable in any case, since such change may at any time occur. Some cases seemingly favorable to its use are found, on examination, to be otherwise; and in almost any mouth in which there is a large proportion of mucus secreted, it cannot be depended upon for permanency. Its color renders it unfit for the anterior teeth. It is a less perfect conductor of heat than gold, on which account it is frequently employed where the latter metal can not be. It should not be used in a tooth in which there is another metal; notwithstanding some dentists do sometimes use it to fill the interior of large cavities, placing upon it a covering of gold. This method is objectionable in two particulars: first, the tin is softer than the gold, and under much pressure yields beneath it, so as to destroy the integrity of the filling; and second, when the fluids of the mouth come in contact with the two metals, a chemical action is induced, by which the tin is rapidly corroded. It is for this reason that no two metals should be applied to the same tooth: as, for instance, tin for filling a tooth round which there is a gold clasp, or in contact with which is a gold plate. Finally, the use of this material should be determined not only by all these circumstances, but also by the constitutional predisposition of the patient

and the character of the teeth, which should be dense and well organized, in order to render it at all admissible. It is frequently very valuable for filling the temporary teeth, and for temporary use in the permanent teeth.

Silver.—This metal, in the form of foil, has never been used for filling teeth except experimentally. It is not for this purpose superior to tin in any particular, except in being somewhat harder; and in some particulars it is inferior, being quite as destructible in the mouth; more easily affected by certain agents, such as nitric acid, nascent chlorine, etc.; less pliable and less adaptable; more difficult to work into foil; not so readily formed into fillings; and possessed of much less cohesiveness, being almost unweldable by the ordinary method of manipulation. Silver is a better conductor than tin, and would therefore in many cases be more objectionable. The saliva is often in such a condition as to act upon it with rapidity. Its color, too, is objectionable. Having these disadvantages, its use has very properly never been adopted.

Platinum.—This metal has been but little used for the purpose of filling, though it possesses some of the requisite qualities in a very high degree; as, for instance, indestructibility, in which property it is superior to gold. In other respects, however, it is

very deficient; it has not as yet been wrought into any form in which it can be welded with facility; it is difficult to work into foil, and when it is put into this form, it possesses a stiffness and harshness that render its adaptation and condensation almost impracticable. It is more on this account, perhaps, than on any other, that it has been so little employed for the purpose of filling. It has also less cohesiveness than gold, and much sooner parts with this property. Slight crumpling or bending serves to stiffen it, so as to destroy its applicability. Good fillings may be made of well-prepared platinum sponge, recently annealed. It requires skillful manipulation, however, for the least moisture destroys its cohesive property entirely. It is a good conductor of heat, and on this account objectionable. In the respect of color, too, it is undesirable. Platinum should never be placed in close proximity to tin fillings, or to gold plate or clasps of low carat. It is, however, being employed to some extent in connection with gold, which in some respects seems to serve a valuable purpose. It is used in the form of foil, of any desired thickness, heavily coated with pure gold. The claims for this combination are, that a far harder and more resistant filling can be made than with gold alone, and a modification of the color of the gold that is far preferable for teeth of certain shades of color.

Gold.—Of all the metals that have as yet been used for filling teeth, gold possesses more of the requisite properties than any other, and sufficiently so for all practical purposes. Twenty-carat gold is very seldom affected by any agencies with which it is brought in contact in the mouth; pure gold never. In the filling of teeth, there are two objects to be aimed at: one, a sufficient hardness to withstand the wear of mastication; the other, a thorough protection to the cavity against all decay-producing agents. For the attainment of the first of these, gold is not all that could be desired; yet it is, perhaps, as efficient in this respect as any other metal that can be employed. But the second object, gold, when well manipulated, accomplishes very effectually: that is, so long as the filling maintains its integrity; after it is partially worn out, it thus far fails, of course. In adaptability, too, gold is superior to any other metal. It can be wrought into a variety of forms, with any of which very good fillings can be made. It can be perfectly conformed to any shape of surface, however irregular. A tooth that can be filled at all, can be filled with gold. This assertion was made a number of years ago; and if it was true then, it is much more true now; for then the cohesive property of gold was not employed at all, or even recognized as available; but now, this property has been rendered

efficient and practicable. Then, our best operators did not aim to unite the different portions of gold of which the fillings were composed. The idea that such consolidation could be effected seemed never to have entered the mind of any one. Indeed, with the instruments and the method of manipulation then employed, this cohesive property could not have been made available; but as it came to be recognized, the instruments and the manipulations were adapted to the purpose. Formerly, an ordinary gold plug when removed from a cavity could be readily separated into as many pieces as originally composed it; but now, when cohesive gold is skillfully used, the mass composing a filling can not be divided into its original parts, but may be wrought into plate, wire, or foil. Non-cohesive gold—the modification in which, till about the year 1859, it was always employed—would not weld, even under great pressure; but in the mode in which it is now prepared, it will weld readily and thoroughly. There are certain requisites essential to this welding property of gold. If it is in the form of foil, it should not present a smooth, planished surface; it must be annealed after hammering, in order that its ultimate particles may be in the best condition for cohering; it must be entirely free from all deposits of foreign substances; and it must be kept from exposure to the atmosphere.

Gold is a good conductor of heat; and this is the chief objection to it as a material for filling. As to sensitive teeth, this is a very serious objection, in some cases necessitating the employment of non-conducting material beneath it, and in others precluding its use altogether. The color of gold, however, is seldom an objection to its use, though it sometimes renders it unsuitable for fillings in the front teeth. But this objection has been already adverted to.

Various Preparations of Gold.—And first, of the manufacture of gold foil. For this purpose pure gold is used, for procuring which various methods are employed. But the most common of these are insufficient for the production of gold absolutely pure. It is, however, deemed irrelevant here to detail the process by which this end is attained: it is enough to premise that, for the manufacture of the best quality of foil, pure gold is indispensable. The gold is cast into an ingot about an inch wide, is then placed between a pair of rollers, and milled down as thin as practicable, the piece, while in this process, being frequently annealed. It is then cut into squares, which are inserted with wooden pliers between vellum leaves, a hundred and sixty or seventy in a pack. Over this pack two pockets are drawn, inclosing it completely. The pack is then hammered on a granite block, with a hammer weighing twelve or

sixteen pounds, till the leaves are spread out to the full extent of the pack. They are then removed from the pack, cut into four sections, annealed, replaced in the pack, and again subjected to the hammer; this process is repeated till the desired thickness of foil is obtained. Much experience and skill are requisite to the proper accomplishment of this part of the work. By a single unskillful stroke of the hammer, a whole pack may be spoiled.

Gold foil is numbered according to the grains contained in each leaf, ranging from 2 to 240. The most common numbers are, 2, 4, 6, 10, 20, 30, 60, 120, and 240—the latter seldom used; of the smaller numbers, 4 and 6 are in most frequent use. It has heretofore been a desideratum to obtain gold foil perfectly uniform in quality. This seems now to be almost if not altogether attained by the most careful and skillful manufacturers.

Crystal Gold.—This form of gold was introduced to the profession about twenty-two years ago. Some experiments in this direction, indeed, had been made as early as 1825, by C. Ash, of London, and again in 1850, by Dr. S. A. Main, of New York. Their preparations, however, were simply precipitates, and nothing more. But in 1853, Dr. A. J. Watts, of Utica, New York, obtained letters patent for this preparation of gold for filling teeth. This preparation

was at first denominated sponge gold, but after some modification, received its present name. There are numerous formulas by which preparations of crystal gold may be made; but so far as we are acquainted with them, they are all embraced in two general methods: the one, to obtain simply a precipitate of the metal adaptable to the filling of teeth; and the other, to combine this precipitate with mercury, and obtain a definite crystallization. For the preparation of the sponge or crystal gold, the absolutely pure metal is required. This is dissolved in nitro-muriatic acid, the gold being added till the solution is saturated. Various materials may be used to precipitate it, the most common of which are sulphate of iron and oxalic acid, the latter on some accounts being preferable. The character of the precipitate will be determined, in a great degree, by the manner in which the precipitant is added: if slowly, the precipitate will take a more definite form, inclining to the crystalline or fibrous.

A preparation may be made by introducing the precipitant gradually, and then carefully washing the precipitate, and heating almost to redness. For perfect crystallization of the gold, combine the precipitate with from six to twelve times its weight of pure mercury; let it stand a short time, subject to a gentle heat, and then remove the mercury with dilute nitric

acid. Afterward wash the nitrate of mercury from the gold; place the latter upon a slide, and bring it up to a full red heat in a muffle, and the gold is then in a condition to be used for filling. This is about the formula on which a patent was granted to A. J. Watts. The preparation possesses some advantages over gold foil. It is as readily introduced; it is more capable of thorough consolidation; it has, besides the cohesiveness of foil, the additional property of interlacing its crystals one with another, by which property, even without cohesion, the pieces of a filling can be firmly united; and it takes a better hold upon the walls of the cavity, to which it presents the angles and ends of the crystals, so as to be more thoroughly adapted and fastened.

Amalgam.—By this term are designated all those preparations formed by a combination of mercury with various other metals; most frequently with silver and tin, but occasionally with gold, platinum, bismuth, cadmium, zinc, and lead. The several formulas for amalgam need not here be specified. The kind most in use is prepared by melting together and carefully mixing pure tin and silver, filing this mixture, when cooled, into dust, combining the latter with mercury in sufficient proportion to give the requisite plasticity, and then thoroughly washing the whole in alcohol or boiling water, to remove the

oxyds formed during the combination of the metals. If there is a redundance of mercury, it may be removed by pressing the paste in a piece of chamois skin. This preparation may in some cases be used for filling with considerable success; but in no case can it be relied upon as a durable material, its destructibility being no less than that of tin or silver in any circumstances, and being greater where all the excess of mercury is not removed from the surface of the filling, and the surface not burnished down solid and smooth. Mercury oxydates with considerable rapidity when exposed to air and moisture, and with increased energy under the influence of heat, especially when some acid is present. This facility of oxydation is still increased when other metals are combined with mercury. Oxydation of such fillings will in some cases be confined to the surface, wherever there is contact of moisture; in others, it will pervade the whole mass, rendering it black and spongy throughout.

Amalgam fillings, in a short time after their insertion, undergo a hardening process, occasioned by crystallization of the mass, as well as by evaporation of the mercury. The consequence is, either that the mass becomes porous, or that it contracts; the former, doubtless, in cases where the oxydation extends through, and the latter where it is confined to the

surface. When a plug is in either of these conditions, the preservation of a tooth is very uncertain. On removing an ordinary amalgam plug that has been worn for some time, its entire surface will generally be found oxydized; and a tooth filled with this material generally becomes blackened, and its appearance ruined.

To such objections against this material, another is to be added in cases in which there are fillings or plate of platinum or gold: galvanic action will be established, in a degree proportionate to the proximity and extent of surface of the metals and the condition of the secretions. This may occasion much mischief. Some constitutions are very susceptible of the influence of mercury; and a gradual decomposition of several amalgam fillings in the mouth may seriously impair the general health. Therefore, before this material is ever employed, the health, temperament and habits of the patient should be carefully noted; for these and other circumstances may often indicate its inadmissibility.

So great and so numerous are the objections to this material, that it is wholly discarded by some in the profession, and but sparingly used by a great many others. Its adaptability is the main property on which are based the arguments in its favor. It is easily applied, and becomes very hard upon crystal-

lizing. It is affirmed, also, that teeth which cannot be saved with anything else may be filled with this, and made valuable. This, however, is not true since the employment of the cohesive property of gold, which quality renders this metal equal in adaptability to amalgam.

Oxy-chloride of Zinc.—This preparation is of a semi-metallic character; it consists of oxyd of zinc and chloride of zinc in combination, and hence is commonly denominated *oxy-chloride of zinc.*

Os Artificial is a conventional name of rather doubtful propriety. This preparation has been for quite a number of years in very general use; and when well prepared, and properly manipulated, serves a very valuable purpose. In some cases it resists the secretions of the mouth quite effectually. For proximal fillings it resists the wear of mastication well, but for crown fillings it is not sufficiently resistant. It is one of the best materials for temporary fillings. A little experience renders its use easy. It effectually excludes all foreign substances, is a good non-conductor, and is only displaced by wear and the solvent power of the saliva in some vitiated conditions. Guilloi's Cement, and Cement Plomb are preparations in all practical aspects similar to oxy-chloride of zinc. Some variation in the method of manipulating them is required. There is found some

difference of susceptibility in these different preparations to the vitiated secretions of the mouth. It is a good protection to sensitive dentine, and in many cases for exposed pulp, under gold filling. It more nearly resembles the natural teeth in color than any other material that has been used for filling.

Non-metallic Materials.—Of the non-metallic materials employed for filling teeth, there are not many worthy of any particular consideration. Indeed, gutta-percha and its preparations constitute the chief of these substances now used for this purpose, though some others have been employed. Gutta-percha is useful for temporary fillings, and, under ordinary circumstances, is sufficiently durable. It is valuable for filling those teeth which it may be desirable to retain only a short time, or those in which it may be necessary temporarily to protect a sensitive part against the influence of irritating agents, in order to restore it to health. Gutta-percha is not readily decomposed by the fluids of the mouth, when they are in a healthy condition. In some instances we have known it worn in the mouth for years with but little change. But in cavities on the grinding surfaces of the molars and bicuspids, it will not withstand the wear of mastication a great while, though long enough in most cases to subserve the purposes of temporary fillings. It possesses great adapta-

bility. By simply being warmed over a spirit-lamp or in boiling water, it becomes plastic, and is with great facility introduced and conformed to the cavity. It may be applied also in solution, being dissolved in chloroform till it approaches a pasty consistence, then absorbed in a pledget of cotton, and introduced into the cavity, where the chloroform evaporating, leaves the gutta-percha as a filling. The only objection to this method is the contraction consequent on the evaporation of the chloroform. Another property that renders this substance highly valuable, is its non-conduction of heat, it being in this respect as nearly perfect as any other material employed.

A preparation of gutta-percha with mineral substances, known as *Hill's stopping*, has for some years been extensively used for temporary fillings; indeed, it has superseded simple gutta-percha almost entirely. The aim of this preparation was to obviate two or three objections to pure gutta-percha; as, its contractibility in the cavity, its softness and its color. The composition of *Hill's stopping* is as follows: With pure gutta-percha in a plastic state are mixed quicklime two parts, and quartz and feldspar one part each, which latter are reduced to an impalpable powder, and kneaded into the mass as long as it will receive them without becoming brittle. Such is the formula given by the inventor of this preparation;

though it is presumed that one of these materials alone, namely, pulverized quartz, would be found entirely sufficient, since it is capable, by itself, of quite as much as is attained by all together. The addition of gold or platinum fillings has been recommended; but no advantage is thus gained. It was at first claimed for this material that it would serve for permanent fillings; but it was soon demonstrated to be insufficient. It was supposed, also, that it might be employed for partial fillings in large cavities, which could be completed with gold; but for this, too, it was found impracticable, since it did not make a sufficiently firm foundation.

This preparation is applied in the same manner as simple gutta-percha, being warmed on a porcelain or metal slab over a spirit-lamp till sufficiently soft, and then packed into the cavity. It cannot be employed in the form of solution, nor should it be softened in boiling water. It may be conveniently prepared by dissolving the gutta-percha in chloroform to almost a pasty consistence, then adding the mineral substances, and putting it into a vessel suitable for the evaporation of the chloroform. It should be made so thick that the silex would not fall to the bottom. When *Hill's stopping* or gutta-percha is used, as soon as the cavity is filled, an instrument with the end nearly as large as the orifice of the cavity, should be

placed upon the filling, and retained there with considerable pressure till the mass is cool. After cutting and dressing the surface of the filling as thoroughly as can be with instruments, then by passing over the surface a short camel's-hair brush, with chloroform, a very smooth surface and perfect finish will be made. In some respects, there is perhaps nothing better for temporary fillings than this preparation of gutta-percha.

CHAPTER IV.

INSTRUMENTS FOR FILLING.

In describing the instruments for filling teeth, it will be convenient to take them somewhat in the order in which they are employed in ordinary practice; first referring to those which are used for cutting away portions of the teeth, for the purpose of separating them, and for dressing off the borders of cavities; then to those for removing decay and forming the cavities; and finally to those for introducing, consolidating, and finishing fillings. The first, then, that claim our attention, are the

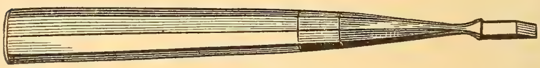
HEAVY CUTTING-INSTRUMENTS.

These are of the thick chisel-shape. They should be of good steel, well wrought, and thoroughly tempered. Every step in the process of their manufacture should be most perfectly executed, so as to insure an edge that will cut not only dentine, but also enamel, which is the hardest animal substance. Various sizes of the straight chisel-form are required.

In all cases they should be as thick as possible, without being thus impaired in their efficiency; so firm

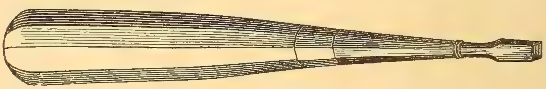
that there may be no springing or tremulous motion under the pressure they are required to sustain. For separating front teeth, however, they must be thin enough to pass readily into the intended space, and

Fig. 3.



about one-fourth of an inch wide at the edge. But for separating bicuspids and molars, the instruments should be thicker and broader; as thick, indeed, as

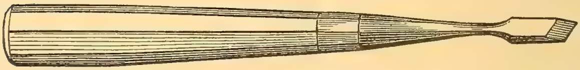
Fig. 4.



the required space will admit. In some cases they should have the edge oblique, as in Fig. 5.

It is seldom that these instruments need any curve.

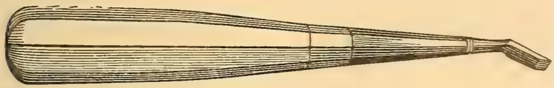
Fig. 5.



The straight form is the best, unless, as rarely happens, the point to be operated upon cannot be reached efficiently with it; as, for instance, in a small mouth, a slight anterior curve will be required in the shaft of the instrument, to facilitate its approach to the front proximal surface of a second or a third molar.

Fig. 6, a heavy instrument, with a sharp point and a lateral curve, is often efficient in opening up

Fig. 6.



cavities and cutting down strong projections of enamel. Fig. 7 we consider as a very valuable form. Every operator should have at hand a suffi-

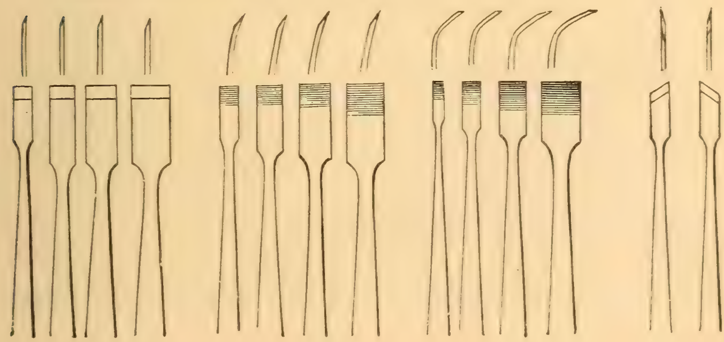
Fig. 7.

cient variety to meet every demand—from three to five sizes of each form.

These instruments are now made with steel handles, much smaller than those represented above, and are used with the mallet.

The following (Fig. 8) will give an idea of the variety of sizes that are desirable :

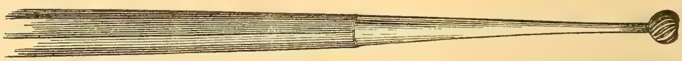
Fig. 8.



DRILLS.

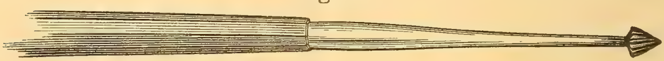
Bur Drills.—Of this indispensable class of instruments there are various forms. They should be manufactured of the best steel, and wrought with the greatest care. After having been forged as near the proper size as possible, the bulb is shaped by dressing with a fine file, or, which is better, by turning in a lathe, those made by the latter method being superior, and cutting much more smoothly; they do not catch and jar as do those of less regular form. After the bulb is formed, it is cut with a sharp-edged file.

Fig. 9.



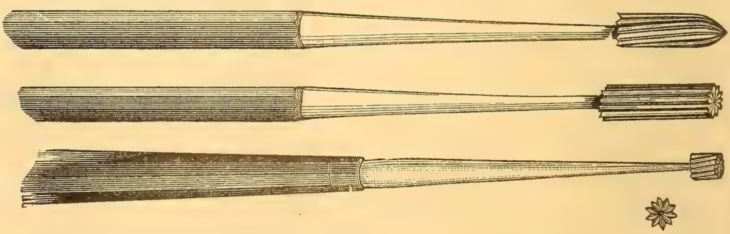
Of these drills, Fig. 9 represents a bur of a spherical form. Fig. 10 is cone-shaped, which may have

Fig. 10.



various degrees of bevel, terminating in a sharp point. Fig. 11 is of a cylindrical form, cut upon the sides

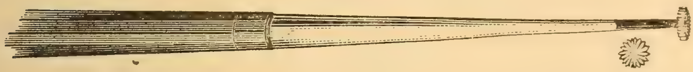
Fig. 11.



and end. Fig. 12 is in the form of a wheel, cut upon

the edge only, or upon both the edge and the end. The cutting upon all of these should be very regular and uniform. This should be made by machinery, though it is usually done by hand. Of these instru-

Fig. 12.



ments, there should be a variety in size, the smallest considerably less than the smallest cavity the dentist ever attempts to fill—that is about one thirty-second of an inch in diameter, and the largest about one-fifth of an inch. Inclusive of these extremes, there should be about ten sizes of each particular form. These instruments are used for opening cavities. With them a more regular and perfect orifice is made in small and medium-sized cavities than by any other method. They are also used to some extent for forming the cavities, and even sometimes, in large cavities, for making retaining-points for a filling.

Some years ago, Dr. Scranton devised a rather peculiar kind of drill, and efficient withal. Its form is spherical, and in its manufacture the bulb is made as for the ordinary bur drill; but instead of having cut upon it numerous serrations, thus forming a series of sharp edges, a concave cut is made upon two opposite sides with a small round file. The instrument then presents two concave and two convex

sides, with four sharp longitudinal edges; these may be so inclined as to cut only when rotated in one direction, or to operate alike well when rotated either to the right or the left.

This instrument has two or three advantages over the ordinary bur; it can be kept sharp with the oil stone till it is almost entirely used up, and will consequently last much longer; and it will cut much more rapidly than the serrated bur. It is a very valuable instrument for operating upon firm, strong teeth. It is represented in Fig. 13.

Fig. 13.

Common Drills.—Of other drills, Fig. 14 represents one with a square point, beveled from both

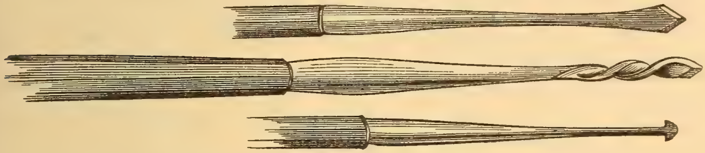
Fig. 14.

sides, measuring from a half to a whole line in width, and attached to a small round shaft. The edges of the drills should be very hard, so that they may cut with the greatest celerity. Of this kind there should be about ten sizes, ranging in width from No. 12 to No. 25 of Stubb's gauge. These

are used mainly for forming retaining-points in cavities.

Fig. 15 is the spear-shaped drill, the edges of which are formed by dressing from both sides; or,

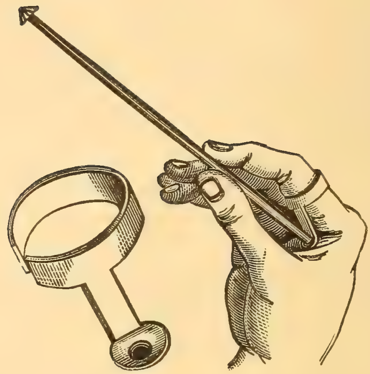
Fig. 15.



it may be, from only one, in which case it will cut only when rotating one way. This shape is employed principally for drilling out roots for filling, or receiving pivot teeth.

The burs and drills may be made of pieces of wire one inch and a half long, and fitted to a socket-handle that will accommodate a large number; or of a continuous piece of large wire. The latter is the preferable method, since much time is consumed in changing them in sockets. The handles should be made with six or eight sides, and cut on each alternate side. In the use of these instruments, the drill-ring is almost indispensable. This is a ring used on the middle or the index finger, with a socket attached, in which rests the end of the handle of the instrument. (Fig. 16.) The drill is rotated commonly with the thumb and fingers.

Fig. 16.



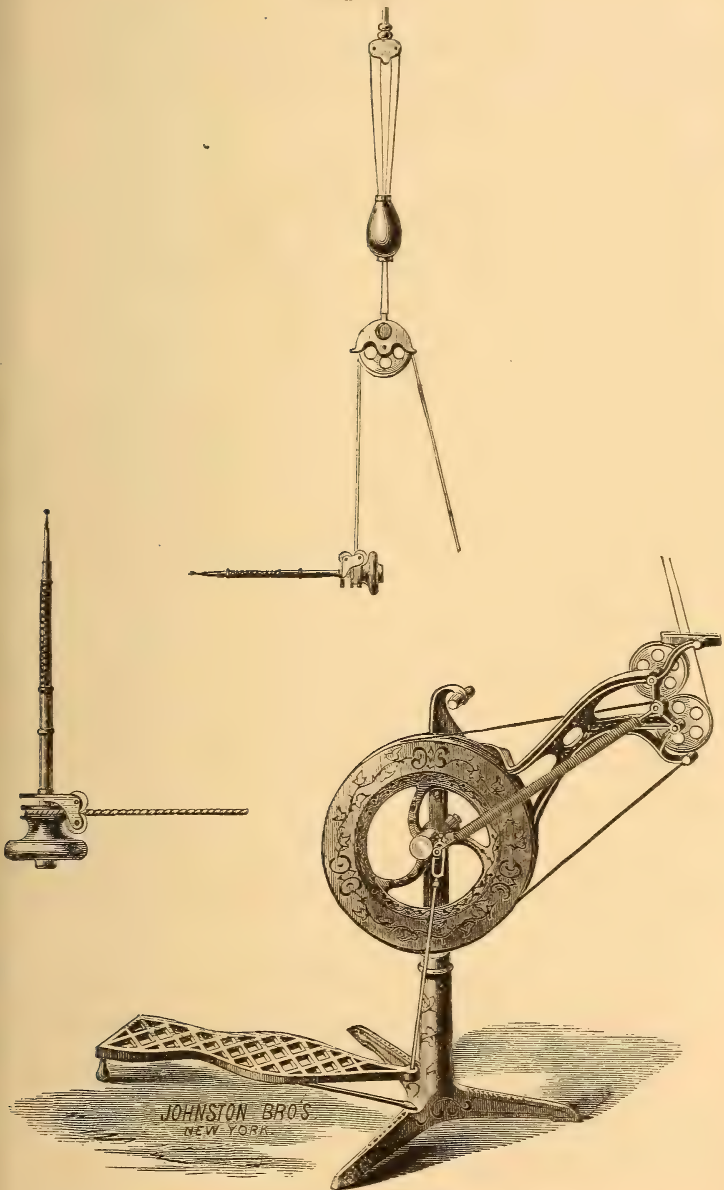
Drill-stocks of various forms have been invented, with the view of increasing the motion of the drill, of augmenting its power, and especially of bringing it to bear upon points inaccessible to the straight instrument.

The use of the burs and drills by the hand, and by means of the various drill-stocks, has been almost wholly superseded by the introduction and use of the dental engine.

This appliance, in a far less perfect form than now, was introduced to the dental profession about the year 1870.

Mr. Green, of Michigan, first introduced the pneumatic engine; succeeding this, was that denominated The "Morrison Engine." Within a short time after this, the suspension engine was devised and constructed by Dr. W. S. Elliott.

Fig. 17.



This engine possesses some excellent qualities. Its steadiness of motion, freedom from tremor or backlash, and the facility of use, are qualities that make it very valuable in these respects. When the large dressing burs or polishing cones are being used, it is superior to any other.

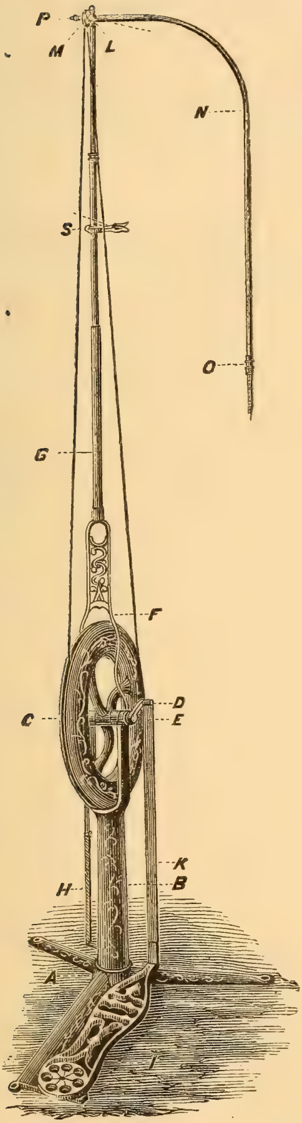
The illustration on page 109 (Fig. 17) gives a correct idea of the machine.

Various other modifications of dental engines have from time to time been presented, a description of which is unnecessary here. That improved by, and bearing the name of, S. S. White, is at present very popular; it has now the most prominent position before the profession; other modifications, however, are highly esteemed by many. It is well represented by the illustration on page 111 (Fig. 18).

This engine certainly posesses many desirable qualities. The facility of movement and adaptation afforded by the flexible cable, and the hand-piece, seem to be about all that can be desired. The mode of attachment to and retention of the drills and other accessories by the hand-piece, leaves little or nothing more to be desired in that direction.

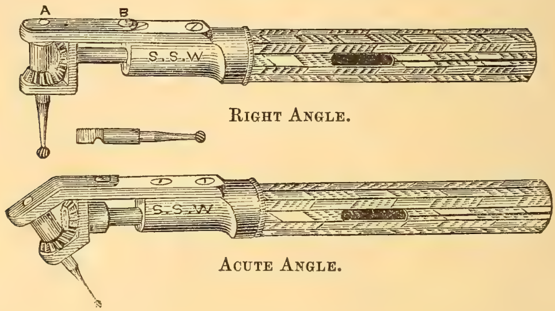
Attachments are made to the hand-piece by which drills are operated at a right angle with the shaft, and also at an acute angle, or with a backward incli-

Fig. 18.



nation to almost forty-five degrees. They are shown in Fig. 19.

Fig. 19.



RIGHT ANGLE.

ACUTE ANGLE.

Some description and illustration of the instruments and appliances used with the engine might appropriately be given here; but so numerous have they become that it is impracticable to give more than a representation of each class.

Fig. 20.

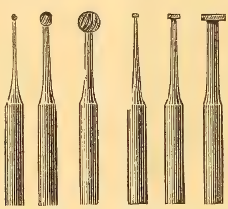
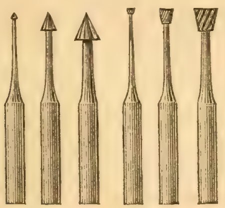


Fig. 20 presents illustrations of the spherical and wheel burs, three sizes. Of each class of burs there should be eight or ten sizes; it would also be well to have two or three grades, as respects fineness of cut: the coarser will serve for rapid work, and the finer for the smooth and more perfect work.

This variation may with propriety pertain to all forms of burs used upon the teeth, and those used for dressing fillings as well.

Fig. 21 shows the cone and the inverted cone-shaped burs; about the same variety in number and size will be required as of the spherical.

Fig. 21.

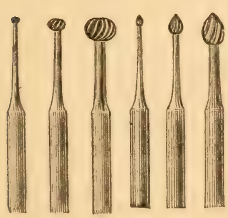


In Fig. 22 are presented the fissure burs, square and pointed.

Fig. 22.

In Fig. 23 are shown the bud-shaped and oval burs.

Fig. 23.



In the following illustration are shown the flexible burs and drills for operations in canals of roots.

Fig. 24.

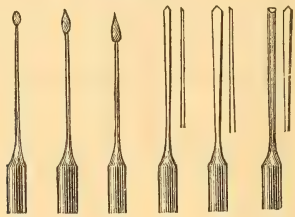
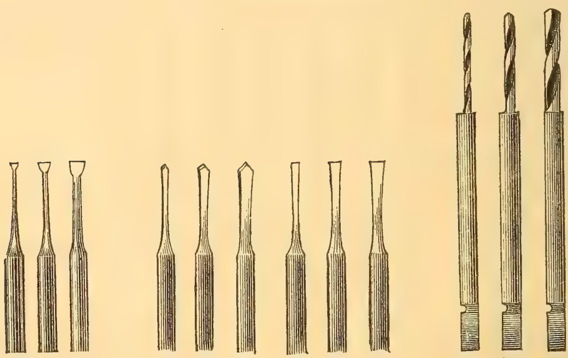


Fig. 25 shows the spear, the square edge, and the spade-shaped drills, all flat, and the twisted drill.

Fig. 25.

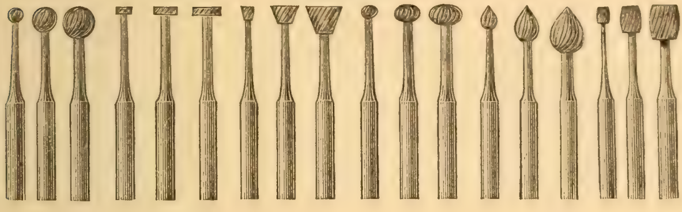


The burs and drills here presented embrace all the principles that have been employed in the ordinary operations upon the natural teeth.

Of the plug-dressing burs a large variety is made; nearly the same general forms have been adopted as in those for operating in cavities of decay.

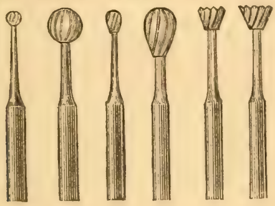
The following illustration gives the most common forms.

Fig. 26.



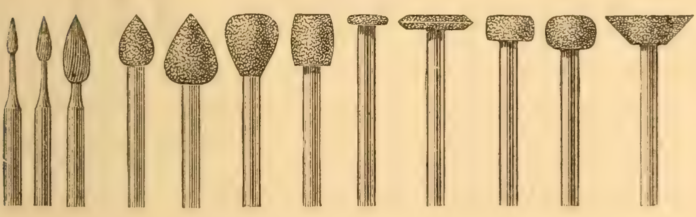
In the following is shown a set of burnishers for finishing fillings.

Fig. 27.



The following illustrates a set of corundum points, cones and disks for finishing fillings.

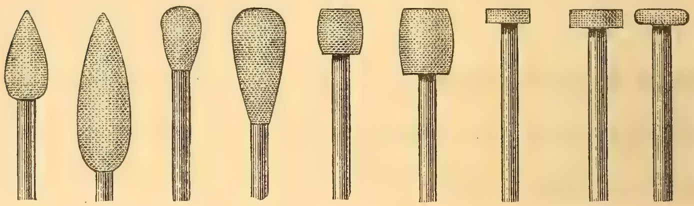
Fig. 28.



About the same forms and sizes of points for finishing are made of Arkansas, Scotch, and Hindostan stones. These are all valuable, and should

always be at hand, and a sufficient variety of sizes to meet all cases. They are shown by Fig. 29.

Fig. 29.

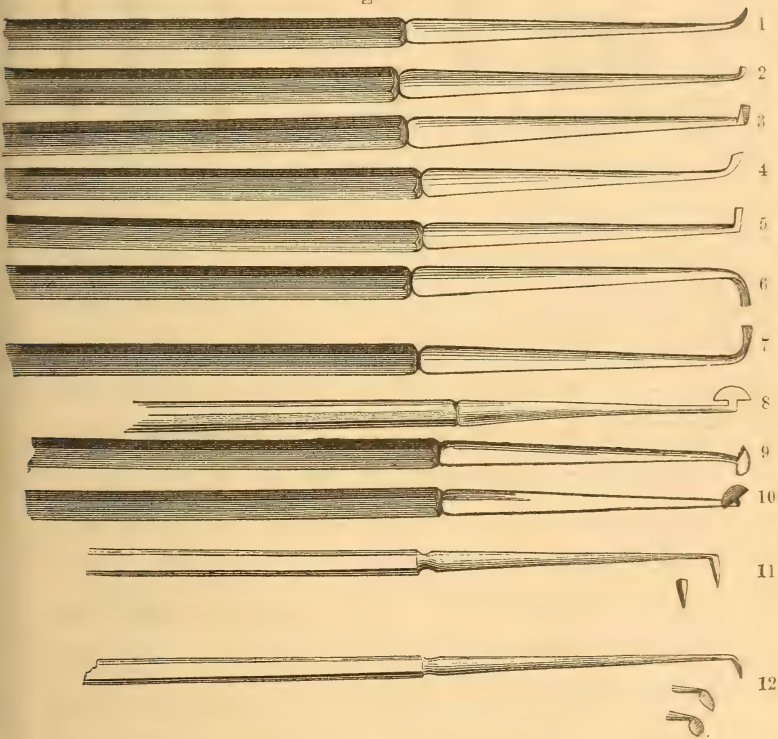


EXCAVATORS.

Of the small cutting-instruments for opening and forming cavities, and removing decay from them, there is a great variety, though a few general forms comprise the whole. Until within comparatively a short time, there has been no very systematic arrangement of these instruments, such as the convenience both of the profession and the manufacturers of dental instruments would seem to dictate. In a classification that we have adopted and found very convenient, they are arranged by numbers, the most simple being placed under the first, and under each successive number a more complicated form. All the varieties are embraced in twelve numbers, which are represented in Fig. 30. These varieties are discriminated by the forms of the points, and their position on the shaft to which they are attached, and not by any curve which the shaft may have at any distance from the point.

No. 1 has simply a flat point slightly curved, with a round edge transverse to the shaft. Four sizes will be sufficient for ordinary purposes.

Fig. 30.



No. 2 has a flat point with a short curve, bringing the point to a right angle with the shaft; the edge is transverse. This differs from No. 1 in having the curve more short and abrupt, and the edge more nearly square. Of these there should be five sizes, with some variety of form.

No. 3 has a flat point with a square transverse edge, which rises at a right angle from the shaft; the blade being from one to two lines in length. Five sizes.

No. 4 has a flat point, curved so as to be at a right angle with the shaft; the blade, from the centre of the curve to the edge, being from one and a half to three lines, and the edge straight. Four sizes.

In each of the foregoing the edges should expand slightly in width.

No. 5 has a flat point with a square edge, which is parallel with the shaft, and rises at a right angle from it. The blade is from one-half to two and a half lines in length, and from one-half to one line in width, with no expansion at the edge.. Six sizes, with some variety of form.

Nos. 6 and 7 are right and left excavators, with flat points and double curves; the first curve being at an angle of about twenty degrees, and the other lateral, right and left, reaching from the beginning of the first curve to the point. The length of blade is from one to three lines. Four sizes.

No. 8 has a crescent-shaped point, the blade rising by a small attachment from the shaft, and making a right angle with it. The edge is a regular curve, describing about two-fifths of a circle, and is parallel with the handle. The point should be perfectly formed. Six sizes.

No. 9. The form of the point is the same as in No. 8, the difference being in the position of the blade, the edge of which is transverse to the shaft, and rises from it at an angle of one hundred and thirty degrees. Six sizes.

In No. 10 the point has the same shape as in Nos. 8 and 9. The cutting edge is transverse to the shaft, and rises by a small neck at a right angle from it. Six sizes.

Such are the most important forms of excavators, though modifications will be required for particular cases. While Nos. 8, 9, and 10 are not in extensive use, a few operators have used them for some years, and prize them very highly. In many difficult cases they are far more applicable than any other instrument we have. For instance, in the formation of the cervical wall of a proximal cavity in any of the teeth, but particularly in the superior bicuspids and molars, there is no other instrument so applicable and efficient as No. 9; with it, that part of the cavity, so frequently neglected, is just as easily formed as any other.

Cases will occasionally be presented in which some curvature of the shaft of the instrument will be requisite. But no more curve should be given to any instrument than may be absolutely necessary, for it is impossible to manipulate with the

same precision and delicacy with curved as with straight instruments. The degree of curve necessary in any given case will be determined by the position of the decay on the tooth, and the location of the latter in the mouth.

The diamond point, as it is familiarly called, is a modification of No. 3, varying from it in that it has a sharp point instead of a square edge, and is three-sided from shaft to point, each angle being a cutting edge. This instrument is especially valuable for forming grooves or furrows within cavities, and for dressing the borders.

After being much reduced by use, it may still be kept in form, and sharp, and used as a drill for making under-cuttings, for which it is very efficient. No. 11 represents this instrument.

A modification of No. 9, commonly known as the scoop or spoon-shaped instrument, is extensively used. The sharp corners of No. 9 are removed in this instrument. It is shown in No. 12.

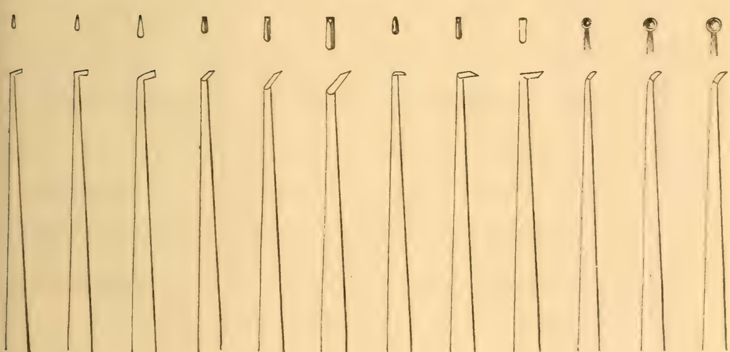
Since the issue of the second edition of this work, efforts have been made by several members of the profession to arrange and systematize excavators into sets, that should embrace every desirable form and size. No one has as yet succeeded in producing that which meets the views of all operators.

There is, perhaps, now more diversity of opinion

and practice in reference to the use of hand excavators, in the preparation of teeth for filling, than ever before, from the fact that a great diversity of practice exists in reference to the use of the dental engine and its accessories for this purpose; some using these almost exclusively in the preparation of cavities; others for this purpose making far less use of the engine, and more use of the hand excavators, claiming that with the latter much more precise and definite execution can be attained.

Fig. 31 presents an arrangement of excavators by

Fig. 31.



Dr. I. J. Wetherbee, very good indeed so far as they extend, and perhaps in the majority of cases they would quite suffice.

Of the Manufacture of Excavators.—For making these instruments, the best cast-steel wire, No. 8, should be selected. This should be forged down

so as to leave the end large enough to form the intended point. Nos. 1 to 6 inclusive, Fig. 30, may be formed by forging, and afterward dressing up with the file. Nos. 8 to 12 inclusive should be formed by the files out of a bulb left from the forge; for this purpose different forms and sizes of files will be required, in order definitely to shape all the angles and points. In heating steel, either for forging or tempering, a full red heat should in no case be exceeded, since a higher degree than this spoils it. After the points are formed, and made smooth with an emery stick or wheel, they are to be tempered; this is a delicate process, requiring much experience and care. The point should be warmed in a spirit-lamp, and then covered with soap, to prevent oxydation and scaling. The instrument is then brought up to a full red heat with a spirit-lamp, blow-pipe, and charcoal, and suddenly plunged into a cake of soap or into cold water, when it will present a silvery whiteness; the steel in this condition is extremely hard and friable. It should then be polished off with an emery stick or oil-stone, and drawn down to the proper temper. This tempering is accomplished by placing the edge of the instrument on a piece of cold polished steel or iron, and its shaft placed near or in the flame of a small spirit-lamp, and

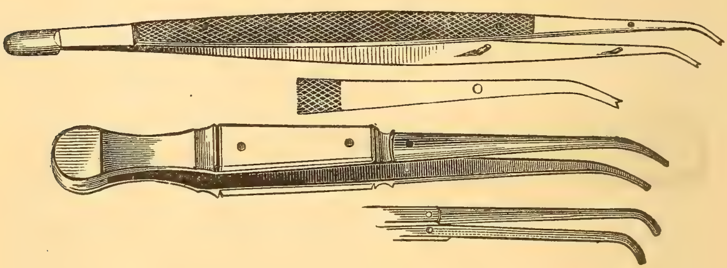
retaining it there till it changes to a deep blue color, graduated down to the point in a deep straw or copper hue. The purpose in holding the point of the instrument on a piece of cold polished iron or steel is, that the heat there may be subject to complete control. The precise shade will be governed by the purpose for which the instrument is to be used; if for a drill, the edge or point should be of a light straw color; indeed, some operators prefer to have them scarcely changed at the cutting edge, while excavators and chisels should be brought to a deep straw or copper color; this will be modified, however, by the manner of working the steel, and its quality. Skillfully hammering steel at a low heat—below a red—adds much to its quality for a fine cutting instrument, and gives an improved texture. Indeed, some assert that those instruments that can be forged to nearly their proper shape, can be as well, if not better, tempered by the hammer as by any other means.

The instrument is then to be polished by the emery wheel and dressed up with the oil-stone. Of the various methods of tempering, the foregoing is equal in efficiency, and in convenience superior, to any other.

FILLING INSTRUMENTS.

For introducing and consolidating fillings, a great variety of instruments is in use. In every form in which gold is employed for filling teeth, the pliers are required for taking up the pieces and placing them in the proper position in the cavity; in cylinder or block-filling they are indispensable. These instruments are made of different forms and sizes—of such forms as to facilitate access to cavities inconveniently located; of different sizes, to accommodate cavities of various capacities. For a large majority of cases, they require a slight curve, about half an inch from the

Fig. 32.



point; for some cases, however, the curve should be a right-angle. (Fig. 32.)

The points of the pliers when closed should present such a form as to be used, to some ex-

tent at least, for consolidating the gold. This instrument should be about five inches long.

The forms of condensing instruments may be multiplied to an almost indefinite extent. They are all, however, but modifications of two or three general principles. The particular form of the plugging point will be determined by the form in which the gold is used. With non-cohesive gold, small square, or round, sharp points of various curves are required. These points are easily kept in proper condition, and in some instances are used for years without any change or repair.

A favorite method of filling with non-cohesive gold, by many excellent operators, is in the use of cylinders or blocks; for this method, instruments especially adapted have been devised, which the following cut represents.

Fig. 33.

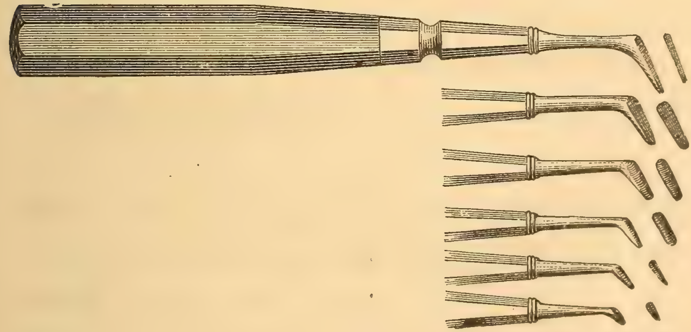
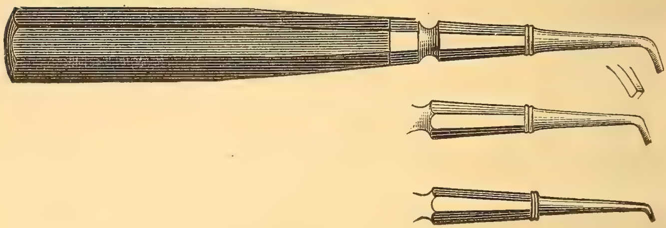


Fig. 34 is square from the curve to the point,

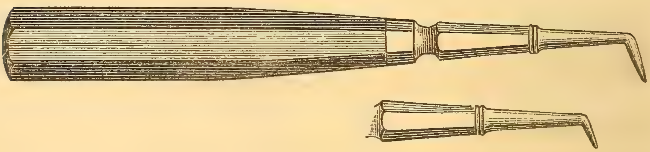
Fig. 34.



and is used in the same manner, and for nearly the same purpose, as Fig. 33.

For introducing and condensing key-blocks—those intended to bind the filling in place—Fig. 35 is the proper form.

Fig. 35.



Figs. 36 and 37 are designed for condensing the surface of crown fillings, in the superior and inferior molars respectively.

Fig. 36.

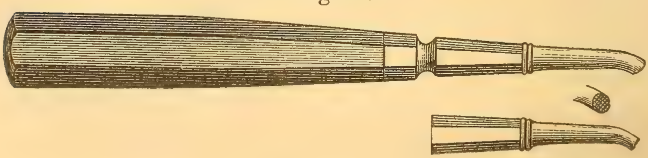
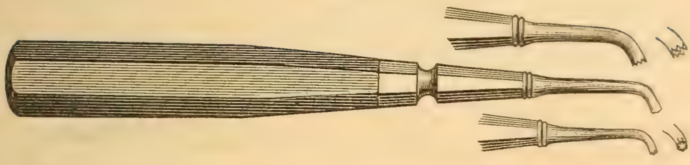


Fig. 37.



The instruments represented by the following are for condensing the surfaces of proximal fillings.

Fig. 38.

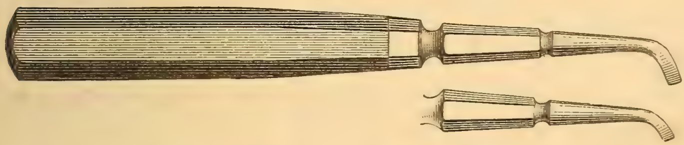
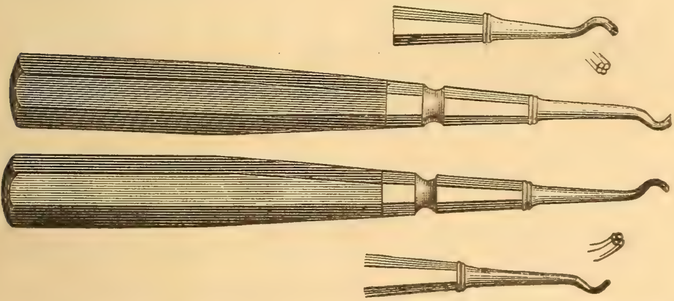


Fig. 39 represents round right and left condensing points, to be used in filling proximal cavities.

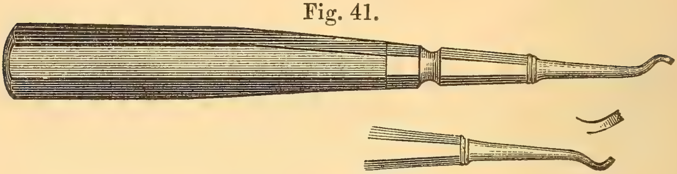
Fig. 39.



Figs. 40 and 41 are flat, right and left condensing points, for same cavities as Fig. 39.

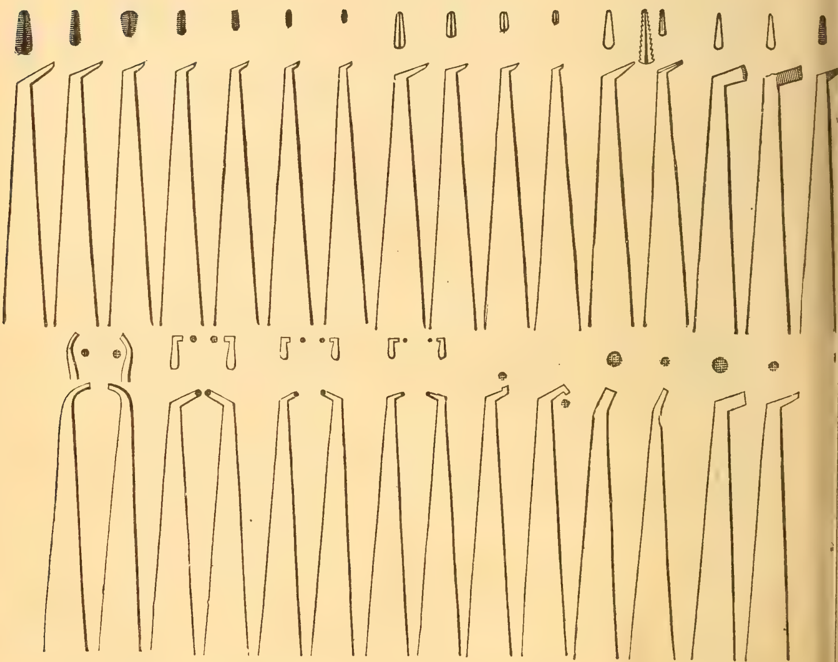
Fig. 40.

Fig. 41.



The following cuts represent a set of filling instruments devised and arranged by Dr. W. G. Redman.

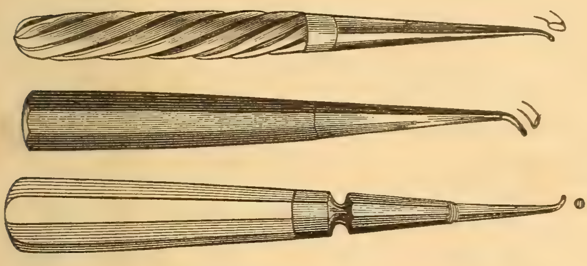
Fig. 42.



They constitute probably the most complete set made, for filling with blocks or cylinders of non-cohesive gold. They are made with ebony or ivory handles, and are used with hand force only.

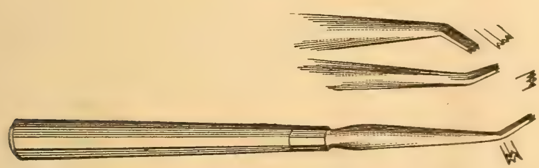
With cohesive gold in any of its forms, the points all require to be serrated. There are three or four varieties of these, which it will be proper to describe. The first is square, and slightly bent about half an inch from the end, which is formed into four or six definite sharp points with the edge of a thin file. Of this variety there should be about five sizes, the largest entering No. 18 of Stub's gauge, and the smallest No. 38.

Fig. 43.



The former should have six points, and the other two sizes four. (Fig. 43.) The cuts upon these

Fig. 44.



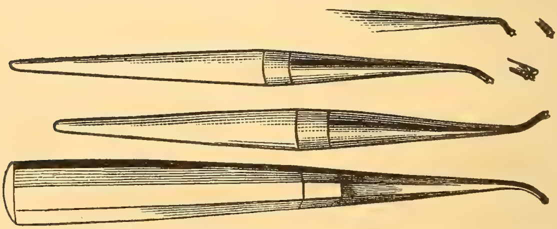
are made directly across the end. In another variety the end is rounded, and the file placed

upon it at an acute angle with the side of the instrument, and the cuts, three in number, are made to the centre of the point, which thus

Fig. 45.

becomes triangular, or three-pointed, from a common centre. (Fig. 45.) Four or five sizes of these may be employed, ranging from 18 to 26, Stub's gauge. A thin double point, from 26 to 28, is in many cases very valuable. Instruments with a condensing surface on the side, instead of the end, will frequently be required for filling lateral cavities; these may be denominated lateral pluggers. (Fig. 46.) This condensing surface should

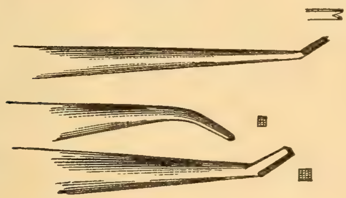
Fig. 46.



also be serrated, as already described. An instrument square at the point, ranging from 18 to 22, and cut upon the end by passing it along the cuts of a file both ways, thus making a large

number of small serrations at right angles across the point, is valuable for consolidating the surface of a plug. (Fig. 47.) Operating superficially, on the principle of the more deeply serrated in-

Fig. 47.



struments, it yet leaves the surface free from deep pits or indentations, and still so impressed that it will receive and retain more gold, if necessary, as it would not do if the end of the instrument was perfectly smooth. A smooth-pointed instrument or burnisher may be applied after all the gold has been added.

Fig. 48.

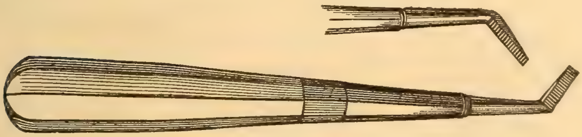
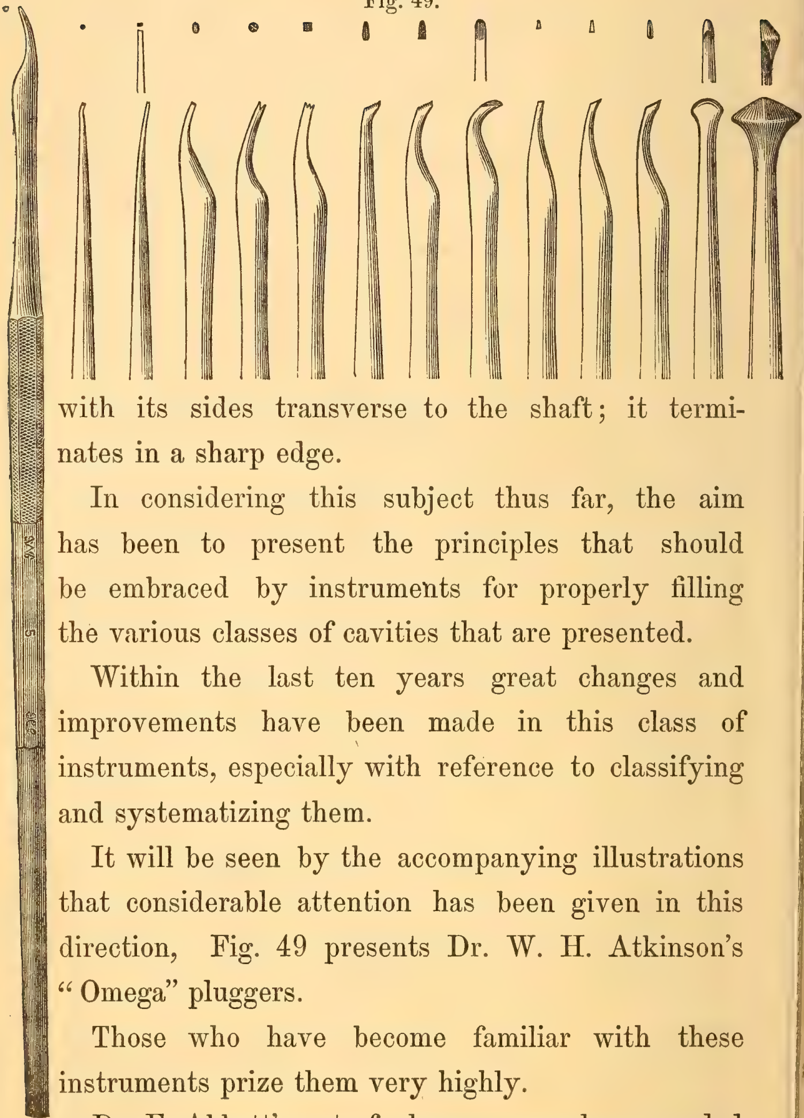


Fig. 48 is an instrument with file-cut sides. It is valuable for dressing down proximate fillings to a uniform surface. There may be two, one with the sides parallel with the shaft, and one

Fig. 49.



with its sides transverse to the shaft; it terminates in a sharp edge.

In considering this subject thus far, the aim has been to present the principles that should be embraced by instruments for properly filling the various classes of cavities that are presented.

Within the last ten years great changes and improvements have been made in this class of instruments, especially with reference to classifying and systematizing them.

It will be seen by the accompanying illustrations that considerable attention has been given in this direction, Fig. 49 presents Dr. W. H. Atkinson's "Omega" pluggers.

Those who have become familiar with these instruments prize them very highly.

Dr. F. Abbott's set of pluggers are also regarded highly by many. (Shown in Fig. 50.)

ig. 50 A.

Fig. 50 B.

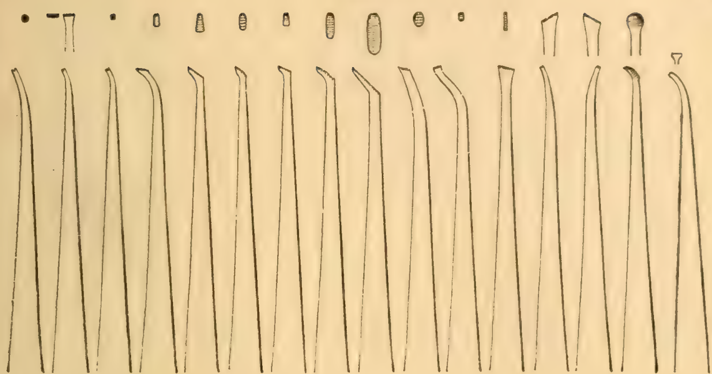
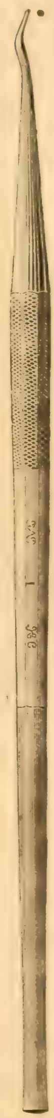


Fig. 51 A.



This cut represents Dr. Lewis Jack's "Matrix" pluggers. They are designed for and are well adapted to operations in which the matrix is required.

Fig. 51 B.

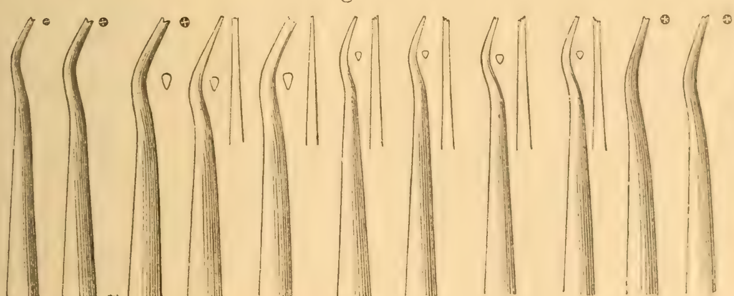


Fig. 52 represents Dr. R. W. Varney's set of pluggers. These were among the first regularly arranged sets of pluggers, and in some respects superior to any that preceded them, and became very popular.

Fig. 53 represents Dr. C. R. Butler's set of

Fig. 52 A.

Fig. 52 B.

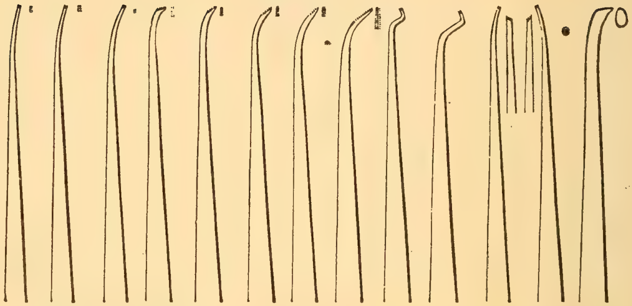


Fig. 5

pluggers, different in some respects from all the others, but excellent nevertheless, and better adapted for some cases.

Fig. 53 B.

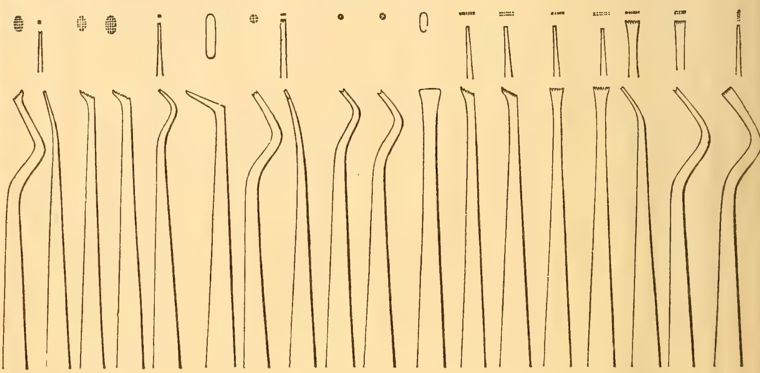
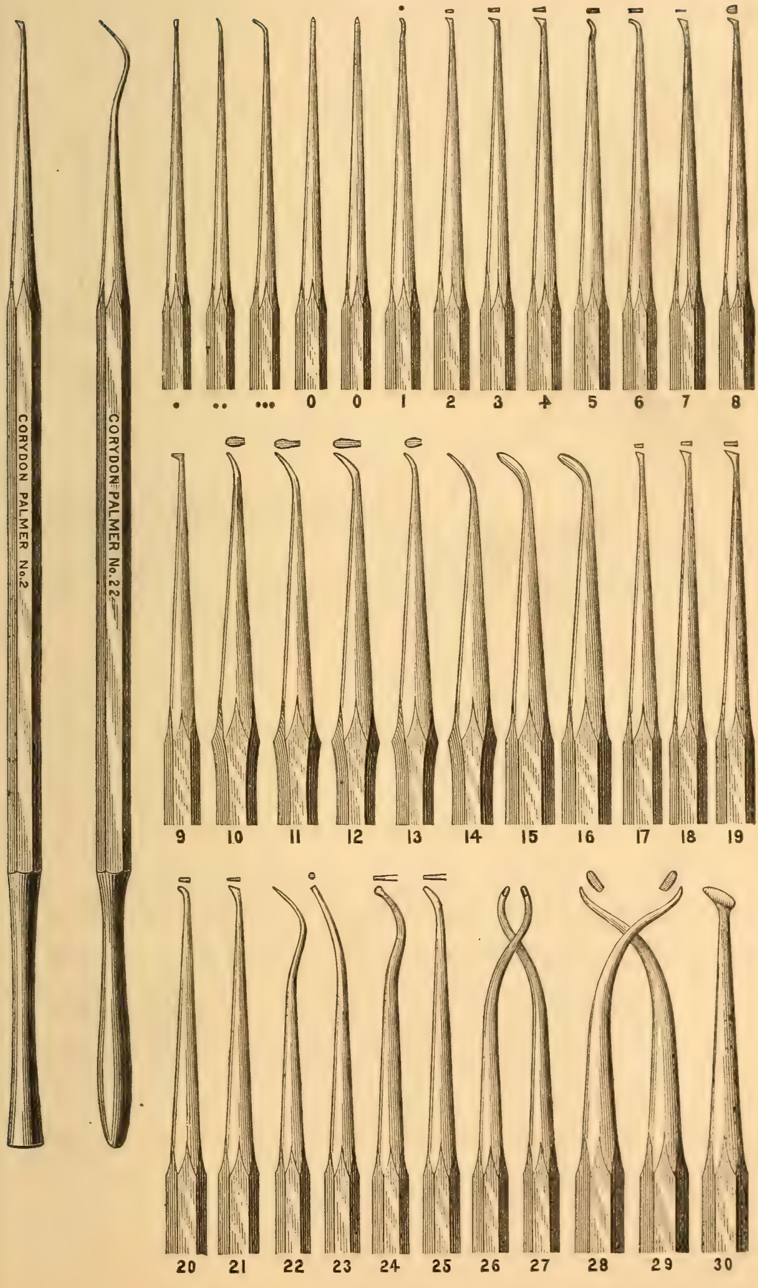


Fig. 54 shows in many important respects the most perfect set of *plugging* instruments ever made. They are the result of long and patient investigation; they will be at once recognized as the work of Dr. Corydon Palmer.

The following cut illustrates them as well as the engraver's art can do it.

Fig. 54.


CORYDON PALMER No.2
CORYDON PALMER No.22
0
0
1
2
3
4
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6
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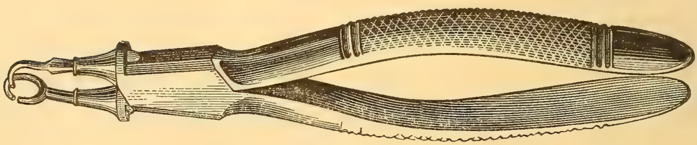
30

A minute description of each, with the directions for its use, is given in section B, in the Appendix.

In many cases a valuable instrument for consolidating is the plugging forceps, the general form of which, except the beaks, is that of the ordinary straight extracting forceps. The beaks are formed into sockets for the reception of the plugging points, one of which is of the common construction, but the other has a broad flat sur-

Fig. 55.



face, to rest against the tooth. (Fig. 55.) This instrument is applicable only in certain cases, principally in filling proximal cavities. Its main advantage consists in its capability of applying a strong pressure upon the filling, without affecting the socket. Manipulation with it is less rapid and definite than with the ordinary condensing instruments; and with it, too, there is much danger of fracturing friable teeth.

There has been within the last few years very great improvement made in the serrated plugging

instruments—those employed for working cohesive foil. It consists in delicacy and perfection of form, a large addition to the variety, and a good systematic arrangement.

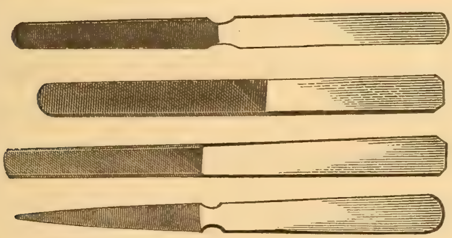
These instruments are now manufactured and put up in sets, embracing every requisite form, numbering from forty to sixty; this includes surface condensers and burnishers.

The profession is largely indebted to the efforts of Drs. Palmer, Atkinson and Abbott, of New York, for the perfection obtained in the production of these instruments.

THE FILE.

Of this valuable and indispensable instrument there are a variety of forms used by the dentist. The thin files (Fig. 56) are chiefly applicable to

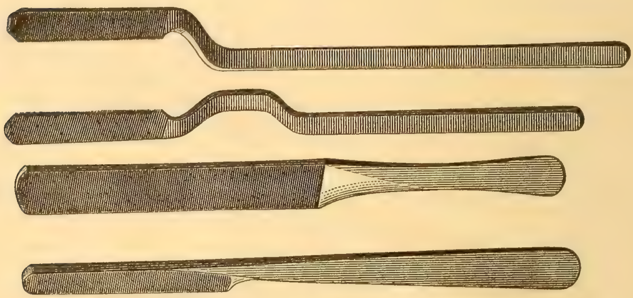
Fig. 56.



the anterior; the thick, heavy, knife-shaped (Fig.

57), to the posterior teeth. The latter, to facilitate their approach to the points operated upon, have various curves, some single, others double; the double being preferable, since they bring the handle of the instrument on a line with its cutting edge. The cuts upon this instrument, too, are

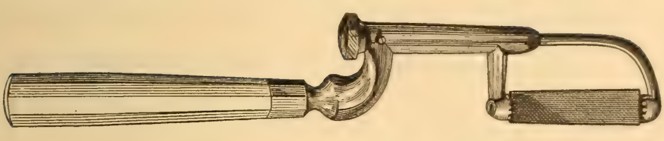
Fig. 57.



quite various; in size ranging from very coarse to very fine, and in obliquity from a line almost at right angles across it to one at an angle of forty-five degrees. These cuts, too, are either single or double, the double being those made across one another. The single, however, are preferable for all operations on the teeth; and the more oblique are to be recommended, since they cause less of that jarring, unpleasant sensation to the patient.

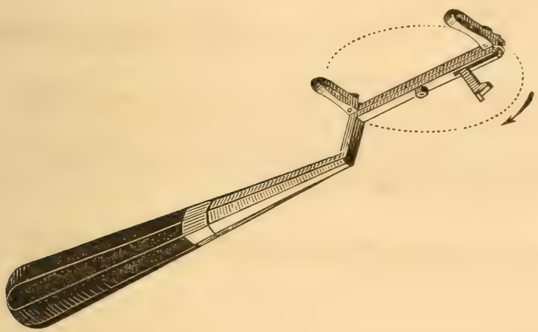
There are in use various forms of file-carriers, two of which are represented in Figs. 58 and 59. Fig.

Fig. 58.



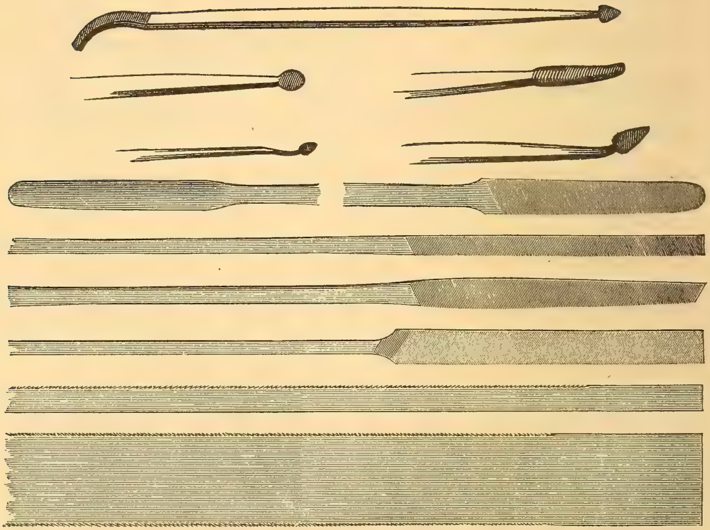
59, denominated "Redman's file-carrier," is an excel-

Fig. 59.



lent instrument, one principal advantage of which consists in the facility with which it may be changed from the one side to the other. Files are made adapted to the instrument: the chief advantage of which is, that it retains the file much more firmly than it can be held in the fingers. These carriers are made with a variety of curves, to accommodate different positions. There is also a great variety of small file-point instruments for dressing down fillings, the more important of which are represented in Fig. 60.

Fig. 60.



The Use of the File.—When a separation of the teeth is requisite, preparatory to filling, it is frequently accomplished, either in whole or in part, with the file. Principally, in such a case, its use is restricted to finishing and smoothing, after the greater portion of the work has been done with the heavy cutting instrument, or in dressing off the thin, attenuated edges. The file is valuable for removing superficial decay, being called into frequent requisition in caries of this kind. It is employed to dress off roots preparatory to the insertion of pivot teeth, for which purpose it is required to be of a round or half-round form. It is used for dressing off sharp portions or edges of the teeth, that may be

injurious to the soft parts, and in some cases for dressing down a tooth that is elongated. In finishing many fillings it is almost indispensable. It was formerly used to some extent in the treatment of irregularity; but for this purpose it has been abandoned.

Mode of Using the File.—The patient should be conveniently seated, with the head on a firm support, and under the control of the operator, who should occupy a position at the right of the patient, in most cases, so disposing the head of the latter as to give free access to that point which is to be operated upon. In manipulating with the file, considerable skill and delicacy are requisite. It should not be held with a stiff, unyielding grasp, so as to catch and jar, but should be applied with a gentle pressure, and drawn across the tooth with a free and flexible motion. It should be frequently moistened, and not allowed to clog with the filings, being kept free of these by repeated applications of the brush. A sharp, new file, with a quick, light movement, will cut far more rapidly, and less unpleasantly to the patient, than one that is dull or clogged, applied with a heavy pressure. If the tooth bone is sensitive, the file should be moistened in warm water. For cleansing files when clogged with dentine, the wire brush in common use is quite efficient. Every operator should have one at hand. The form of a file

may be changed by drawing the temper, bending it as desired, and then re-tempering it. It is better, however, to have them made of the proper form at first.

The teeth, while being filed, should be supported by the fingers, or by an instrument for the purpose; or a cork or piece of soft wood may be inserted between the tooth being filed and the teeth of the opposing jaw, and the pressure thus used as a support. The tooth being sustained in this manner, there is less jarring experienced by the patient, and less liability to produce irritation of the periosteum. When filing the anterior teeth, it is generally better to hold the file in the fingers. For filing the incisors and cuspids, a thin, bevel-edged file is to be preferred. In dressing a tooth with a file, the last that is used should be a fine one; after the application of which, the surface operated upon should be made as smooth as possible with a stone and burnisher, or with a buff and rotten-stone.

In separating teeth with the file, where but one is decayed, care should be taken not to cut the sound one. For this purpose, it will usually be necessary to have a safe sided file—one side smooth to present to the sound tooth; and even then the cutting edge should be somewhat beveled from the safe side, that the sharp angle of that edge may not rasp the sound tooth; in no case of this kind should a square-edged

file be used. In cases in which it is necessary to file teeth that are somewhat loose in the sockets, and whose periosteum is in a state of irritation. to build up a wall of plaster of Paris round them, permitting it to harden, will very much facilitate the operation. Perhaps a preferable method, in some respects, for accomplishing the same object, is to mould softened gutta-percha to the tooth and the parts about it. After it has become hard, hold it firmly in place while the filing is accomplished. Either of these methods will be found valuable in cases where it is necessary to dress off a considerable portion from the end of one or more of the inferior front teeth. There are some teeth upon which the use of the file is hardly admissible; as, for instance, those which are highly predisposed to inflammation and sensitiveness of the dentine. The teeth of young persons, being often of this character, should be filed with great caution; but, in general, those of adults may be filed, if properly done, with more freedom. The file should not be used upon the teeth when the periosteum, the gums, or the mucous membrane is diseased, or strongly predisposed to such a condition. It should never be used for the correction of irregularity of the teeth, especially when they are sound; nor should it be employed to separate sound teeth to introduce clasps.

Filing the teeth is an operation against which there has been, and still is, much prejudice, though without sufficient cause. Whatever injury results from this operation, is from the imperfect manner in which it is performed, and from subsequent neglect of the tooth which has been subjected to it. A tooth skillfully treated with this instrument, and properly cared for afterward, will not be more liable to decay at the point operated upon than at any other where the dentine may be exposed.

CHAPTER V.

SEPARATION OF THE TEETH.

In most cases of proximal decay, the teeth, before the operation of filling can be performed, must be separated; though cases are not unfrequent where the space between them is sufficient to admit of free manipulation without this preliminary. An imperfect accomplishment of this first step in the process of filling is a prolific source of the many failures, in proximal cavities, to attain to efficient and durable results; for unless this step be thoroughly performed, so as to make room for the free introduction and use of the various instruments requisite, no part of the work can be complete. Though the most common object for which teeth are separated is to obtain space for free manipulation with the instruments in filling, yet there are various other objects for which they have been separated, but many of which are now better accomplished by other means. It is sometimes necessary to cut away more than would otherwise be requisite, in order to remove thin, friable edges of the cavity, so as to obtain sufficiently

firm borders. Teeth are in some instances separated for the introduction of clasps—a practice always to be deprecated, since it usually proves highly injurious. Though the practice was once very common, yet most if not all the best operators have now, with good reason, abandoned it altogether. At one time, too, it was a general practice to separate the teeth with the file to relieve a crowded condition; but this, also, has been abandoned.

There are two methods of separating the teeth: the one, to cut away a portion; the other, to force apart by pressure, acting upon one or more teeth, as the circumstances admit. Formerly, all separations were effected with the file, and this of very crude form and cut, by which instrument, especially in unfavorable cases, much injury has been done. Though the file is a valuable instrument, one that none other could supply, yet, for removal of any considerable portion of dentine, it is not to be recommended. Its action upon inflamed dentine is exceedingly painful, besides being tedious and wearisome to patient and operator; it is also liable to irritate the periosteum, and to increase inflammation. When a separation is to be made that requires the removal of a considerable portion of the tooth, the chisel, or heavy cutting instruments, illustrated on pages 102 and 103, are to be preferred. These, if of the proper form

and temper, and in good condition, are very efficient for the purpose, performing the work far more rapidly than the file, and far less unpleasantly to the patient. They effect the removal of sensitive dentine with but little or no pain, and without liability to increase the inflammation, or to produce irritation or disease of the periosteum. The force of these instruments is sustained by the entire attachment of the tooth, their pressure being applied almost in a line with its axis. Besides, by their use, the contiguous teeth are not liable to injury, as by the use of the file they often are.

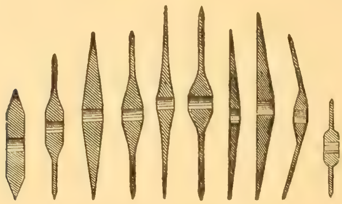
The manipulation with these instruments is very simple. For separating front teeth, the instrument is firmly grasped in the hand, the thumb placed on the points of the teeth, and the edge applied at the point or crown surface of the tooth from which the portion is to be removed, and pressed gradually toward the gums, but not thrust into the interval as a wedge before it has freely cut its way. In this manner, as much of the dentine as it is desirable to remove is cut off in a few moments. This class of instruments is invaluable for forming the V-shaped spaces between the bicuspids and the molars that have been popular with many operators, but are pointedly condemned by others. It requires a prolonged use of the file to make these separations properly; and hence the practice of attempting to fill

proximal cavities without any separation at all, by operating through a small opening at the crown angle of the tooth, or a small hole drilled through its outer or inner portion. With the heavy cutting instruments, points upon the teeth that the file cannot touch are approached and operated upon with facility. Another method of effecting the same kind of separation is, by the use of the corundum disks, used with the dental engine.

The profession is indebted to Dr. Robert Arthur for devising and rendering practicable this very valuable appliance.

These disks, as seen in the following illustration, are made of various forms, suitable to meet all cases.

Fig. 61.

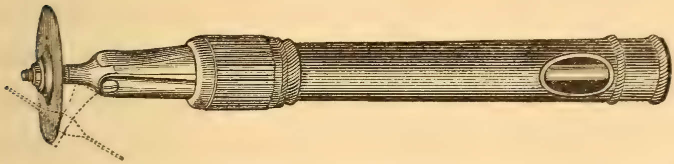


For using the disks, carriers have been devised and made. These should possess three qualities, viz.: ready adjustment to the hand-piece of the engine; facility of attachment and release of the disk; and the easy change of the disk to any desired angle with the shaft containing it. That invented by Dr. Geo.

H. Cushing possesses these qualities in a marked degree, and is very effective.

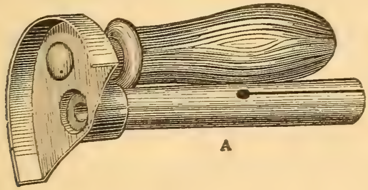
The dotted lines in the figure show the angular range of movement of the disk upon its shaft.

Fig. 62.



For convenience and safety in using the disk, a shield or covering is adapted to it that effectually protects all parts except that operated upon.

Fig. 63.



By means of this instrument, separations of little more than a mere opening to the largest V-shaped space can be readily made, and it is claimed with equal if not greater ease to the patient than by any other method.

Skill and experience are required for their facile use.

It is claimed that the use of the disk will largely supersede that of the file for separating teeth.

But the method of separation by pressure is in

many cases to be preferred, especially in the case of anterior teeth, whose natural form it is important to preserve.

Till within a comparatively recent period, it has been the general practice to separate by gradual pressure; and it is even yet the favorite method with some operators. But in almost all cases where separation is to be made by pressure, it can be done at once quite as well, if not better, than to prolong the process through several days; there is economy of time, and the patient has far less to endure, and there is less liability of doing injury to the teeth or the parts about them.

The anterior teeth, or those of single roots, yield very readily to a strong separating force, applied in the form of a wedge, notwithstanding the teeth may all be in contact with each other; though in some cases the teeth are so firmly set, and the parts about them so dense and unyielding, that it is with great difficulty they can be moved, without too much violence to the parts. It is not generally practicable to attempt to separate the molar teeth by pressure.

The method of effecting immediate separation is very simple; it consists in forcing a wedge of some fine-grained wood of medium resistance—orange or box wood—between the teeth to be separated, either by pressure with the hand, or, better, by the blows

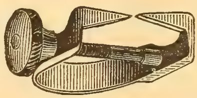
of a mallet. The wedge should be driven in at the necks of the teeth; before this, however, a shield-wedge should be put in between the necks of the teeth against the septum of gum; it should be of such form as to retain its position while the chief wedge is being driven in; and when they are very firm, an assisting wedge may be used, inserted between the points of the teeth, and receiving strokes alternately with the other. The assisting wedge should be of very dense wood, and driven in with great care, for its leverage upon the teeth is very great. When the required space is obtained, the wedge at the necks of the teeth should be driven tightly in, and the other withdrawn. If all the teeth in the vicinity of those to be separated stand in contact, the resistance to separation, whether by immediate or gradual effort, will be greater.

Two forms of appliances, denominated separators, invented by Dr. Jarvis, are very valuable aids in the separation of the teeth. The one is for separating the anterior and the other the molar teeth. The former is described as consisting of two wedges approaching and passing each other; being thus drawn together by a thumb-screw, making gradual and prompt separation where it is applied.

Its operation is much more acceptable to the patient than that of the ordinary wedge driven with the

mallet. It will be found useful in making room for passing rubber-dam between crowded teeth. It may also be used to advantage in connection with the wedges.

Fig. 64.



That for the molars consists of a properly-formed piece of steel, bent upon itself, with the ends formed to fit the outer and inner portions of the proximate surfaces of two adjoining crowns.

These jaws are forced apart by the action of a screw, which passes through one and against the other.

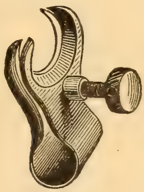
This form is applicable to all the bicuspids and molars. It does not touch the gum or injure the teeth, neither does it cause much pain.

The appliance may remain on the teeth in some cases while an operation is being performed; otherwise a wooden wedge should be inserted between the teeth. It is represented by the following figure.

The rapidity with which the operation may proceed, and the extent to which it may be carried, will be determined by the tolerance of the parts to the movement, which should not be greater than the elasticity of the tissues will permit; not the slightest

laceration or rupture should be made; again, great care should be observed, lest strangulation of the vessels that enter the roots, pass to and supply the

Fig. 65.



pulp, be effected; this would be far more liable to occur in the teeth of young persons, or before maturity. There is in adults, however, a great diversity in their susceptibility to injurious influences.

Many operators still prefer gradual separation by pressure. In order to secure the most successful results, the conditions of the parts should be strictly observed. The gums, periosteum, etc., should be in a healthy condition; for much injury may be done by attempting to separate teeth by pressure, when the contiguous parts are in an irritable state. In persons of a neuralgic diathesis, in those whose vital energy is weak, and particularly in those whose constitutional tendency is inflammatory, this operation is scarcely admissible. If, in such cases, it is attempted at all, it should be proceeded with very carefully and gradually, and should be preceded by constitutional treatment. There are many cases in

which it is best to make the separation partly by pressure, and then to complete it by dressing off the thin, friable edges of the cavity with the cutting instrument or file. Whether the process is to be wholly or only partly accomplished by pressure, should be determined beforehand.

Various materials have been employed for separating the teeth by gradual pressure, the chief of which are cotton, wood, India rubber, and ligatures. The condition and character of the parts to be operated upon will indicate the material best adapted in any given instance. In a good constitution, with the teeth firmly set, and the contiguous parts healthy, wood or India rubber may be applied; but in cases of an opposite character, a more yielding and tractable material is indicated. The degree of pressure to be applied and continued will be determined by the susceptibility of the parts to irritation. Soreness usually occurs in a few hours after the introduction of the material. The pressure should be gradual and constant, slight at first, and increased in force as the patient will bear; the increase being made every day, and continued till ample space is obtained. The time necessary for the completion of this process is from ten to twelve days; only one separation should be made at a time. The teeth should be retained apart till the soreness has abated, before the operation.

If not thus retained too long, they will return to their former position. It is by some supposed that separation by pressure is admissible only in the case of the young, or those under thirty years of age. It is true that they are the most susceptible; but the operation is, under favorable circumstances, proper at any age.

CHAPTER VI.

FILLING TEETH.

THE operation of filling teeth is an interesting and important one, requiring for its successful accomplishment peculiar talent and large experience. It is the only means as yet ascertained of completely effecting the object for which it is employed, namely, arrest of decay and preservation of the organs. Therapeutic agents avail but little here, so low is the organization, and so feeble the vital power. Nature, so efficient in more highly-organized structures, does comparatively little in disease of the teeth toward arrest or restoration. Yet, on the other hand, these organs are less liable to decomposition by the action of foreign substances; indeed, well-organized enamel is almost invulnerable to any agents to which it is ordinarily exposed. The dentine, however, is more easily acted upon, and, when there is defect in the enamel, is very liable to injury.

Scarcely an individual in our country arrives at mature age with a perfect set of teeth; indeed, nine-tenths of our people have decayed teeth at an early

period of life. Hence, for beautifying, preserving, and supplying these organs, art is in constant requisition; and in these respects great achievements have been made. In the operation of filling the teeth, especially, the achievements are conspicuous; and here is scope for the highest skill. Every successive step in the process of filling a tooth demands a complete and conscientious application of the most efficient and best adapted modes and appliances of the art. In the following remarks it is proposed to analyze this whole process, examining, in their order, the various steps necessary to be taken, and endeavoring to inculcate the true methods of accomplishing them.

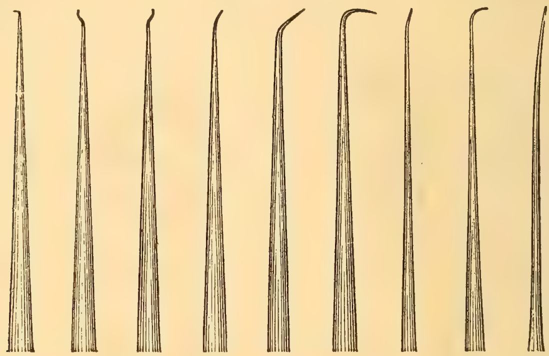
EXAMINATION.

When a case is presented, there should first be a thorough examination, since by this all the subsequent work will be modified. For this purpose the proper exploring instruments should be at hand, which should consist of a sufficient number and variety of fine sharp-pointed instruments, so formed and curved as to be readily brought into contact with every point of surface of the crown of every tooth, and indicate any defect that may exist.

The accompanying cut represents the common and perhaps the best forms of this class of instruments.

In addition to these, mirrors, reflectors and magnifiers, when properly adjusted and skillfully used, are very valuable.

Fig. 66.

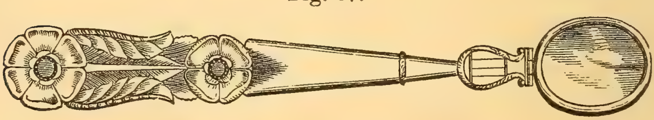


There should be two or three sizes of mirrors, adjustable to any angle requisite to reach every point in the mouth efficiently.

Reflectors are desirable for throwing light upon obscure or dark points.

Magnifiers are important in examination of the teeth, to bring to view defective points that would escape detection by the unassisted eye. Every operator ought to have at hand at least three grades of

Fig. 67.

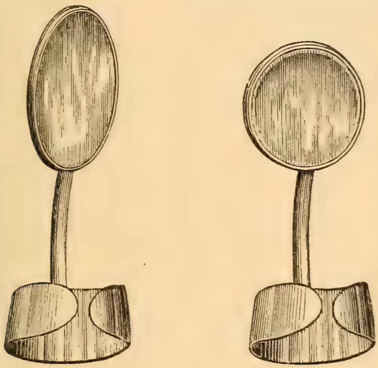


these. Mirrors and magnifiers are combined to some extent, but sufficient amplification and definition

cannot be obtained in this way for all cases. The common mouth mirror is shown by Fig. 67.

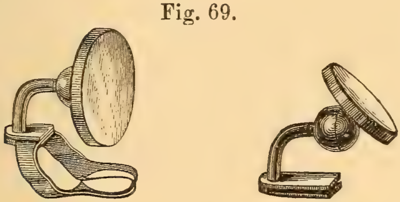
Mirrors and reflectors are made adjustable upon the finger of the operator, as in

Fig. 68.



Reflectors adjustable on the rubber-dam clamps serve a valuable purpose, and should always be at hand. Shown in

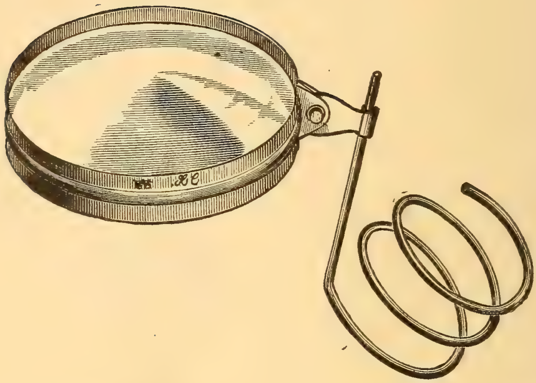
Fig. 69.



They are also attached to the rubber-dam clamps, which makes, for many cases, a very convenient arrangement.

Fig. 70 is a magnifier, to be used on the finger of the operator. The chief use of the magnifier, however, is for examination rather than for operating.

Fig. 70.



The points to be noted in the examination are as follows:

The temperament; the present health; the constitutional tendencies; the secretions,—the saliva and mucus; the mucous membrane and the gums; the constitution and condition of the teeth; the number of them remaining in the mouth; the number affected; the extent and nature of the decay, and the character of the agents producing it. By the examination we ascertain how to proceed in the operation; if much or but little labor is required; whether the operation will be a simple or a difficult one; and if difficult, what circumstances render it so; and, besides, some conclusion is arrived at in regard to the precise means to be employed for obtaining the desired result, as well as the permanency of that result.

OPENING.

The next step is to open the cavity of decay, so that it may be approached and operated upon at all points. The particular manner of performing this is determined by the extent of the decay, and its position upon the tooth. In all cases the opening should be such as to give free access to all parts of the cavity, for effectually removing the decayed portion, for perfectly forming the cavity, and for introducing, thoroughly consolidating and finishing the filling. In central crown cavities of the molars and bicuspids, the projecting or pendent portions of enamel should be cut away. There are cases, however, where such portions are firm and not liable to be broken, and where they can be well sustained by filling under, in which it is admissible to leave some projection. This is true of only those teeth which are of good, firm texture. There are two objections to these abrupt projections of enamel: it is very difficult, and in many cases impossible, to fill perfectly beneath such portions; and again, they are liable to be broken down during mastication.

For opening up these cavities, in many cases the bur drill alone will be quite sufficient; those of different sizes being employed, to open up the orifice gradually, so that too much violence may not be done

to the teeth. In all very small cavities, the bur is all that is required, except in decayed fissures, and for these the fissure bur is almost indispensable.

In cases where the decay is more extensive, and the cavity larger, the chisel or heavy cutting instrument, in connection with the drill, will be found very useful. Fig. 71 represents valuable forms of these instruments.

Fig. 71.

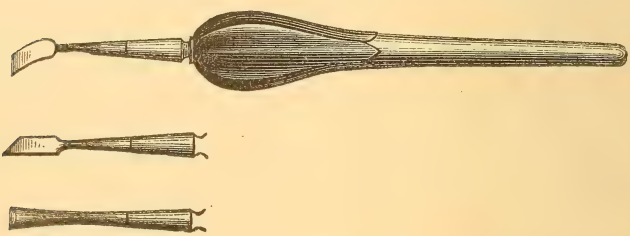


Fig. 8, page 103, represents instruments for this purpose, of various forms and sizes; they may be used either with hand force or the mallet. In cases where much cutting is required, the latter method is preferable, being more rapid in execution, and less objectionable to the patient.

The fine file or bur should always follow the use of the chisels, to give a smooth and even surface to the part upon which the cutting has been made.

REMOVAL OF DECAY.

After the cavity is opened, the next step in order is the removal of the decayed dentine. As a general

rule, this should be entirely removed. There is, however, some variety of opinion upon this subject. This difference of opinion is in regard to cases where an entire or a partial decomposition of the dentine has taken place quite to the pulp, where, by its removal, the pulp would be exposed. It is maintained by some that decayed dentine affords a better protection to the pulp than any artificial covering; and hence it is better to let it remain, since its adaptation is more complete; and it is not in every sense a foreign substance.

On the other hand, it is contended that the decayed dentine, being in an abnormal condition, will irritate, and in many cases ultimately destroy, the pulp. And again, that there is danger of making undue pressure upon the pulp, in filling on such softened portion.

In many cases it is maintained that partially decomposed dentine will become dense again, if protected from the influence of foreign agents that decompose it. This sometimes would seem to be true. For in some cases where fillings have been introduced into cavities, at the bottom of which a portion of softened dentine covered the pulp, on removing them in from one to five years afterward, all parts of the cavity were found to be equally and normally dense. This, perhaps, would occur only

in good constitutions, and under favorable circumstances; but with such constitutions and circumstances, where the softening is not too extensive, and the decomposition but partial, it may be permitted to remain, with a strong probability of a favorable result. This would certainly be better than to cut it all away, and expose and perhaps wound the pulp, and then endeavor to cover it with some wholly foreign material that would not be perfectly adapted to it, that would press a little too hard at one point, and not touch at another, and that would be quite as liable to be pressed down on the pulp as the softened dentine.

In this discussion, much depends upon the point whether partially decomposed dentine can retain its vitality. This it is not now proposed to consider. There are some particulars in regard to the removal of decay, however, about which there is no diversity of opinion: first, that all decomposed dentine should be removed from all parts of the cavity, where the pulp would not be exposed or injured thereby; and that in *all* cases it should be entirely removed from the lateral walls of the cavity, and especially from the vicinity of the orifice. Even discolored dentine should be removed from this part, unless weakening of the borders or walls would thereby be occasioned.

Dentine often becomes changed in color when

there is no apparent decomposition; such portion is usually, though not always, without vitality. It is not important to remove such changed portion, except for the appearance of the tooth; it will produce no change upon the living or normal part beyond it; and it is better material to be in contact with the living part than any metal of which a filling may be made.

Decayed dentine is readily removed with the excavators. In any given case, such instrument should be selected as would be best adapted for the purpose, as well in regard to size and the form of its edge, as to the curvature, or inclination of its shaft. The edge of the instrument should come upon the walls of the cavity at such an angle as to accomplish the work most efficiently. It should be very sharp, and pressed firmly to the bottom of the decay at one side, so as to remove the principal part at one cut. So far as possible, the direction of the cutting should always be from the nearest point of pulp exposure, toward the orifice of the cavity. With the proper instrument, and that in the right condition, all the decay should be removed from any cavity by a few, firm, steady strokes. By this method less pain is caused the patient, and the work of the operator is facilitated. It is intolerable to think of being subjected to an awkward, clumsy hand, with

a dull, ill-shaped excavator, scratching upon the surface of a decayed tooth, for a length of time, apparently to the patient interminable.

FORMING CAVITIES.

The next step in the operation is the formation of the cavity. By this the cavity is so formed that it will well receive and retain the filling when properly introduced. In very few cases is the cavity of proper form when the decay is removed; but in almost every instance more or less of the solid dentine must be removed to secure a proper form to the cavity. Much time, patience and labor are required of the operator for the proper accomplishment of this part of the work, and much endurance on the part of the patient. In this part of the work several particulars require consideration. The great object, however, is to give to the cavity such a form as will secure the most perfect adaptation of the filling to every point, and its permanent retention in place. The cutting for the formation of the cavity should be accomplished with the least possible loss of healthy dentine; this is a point upon which good judgment should be exercised. The strength of the walls of the cavity, and the ability of the parts to withstand the pressure, both in the intro-

duction and consolidation of the filling and in the act of mastication, should be well noted. It may be regarded as a rule from which there should scarcely ever be a departure, that the enamel should never be encroached upon, through the dentine, in excavating to give form to a cavity. When there is but a lining of dentine at any given point on the enamel, after the decay is removed, it should remain for the preservation of the enamel; it should not be cut through either by pits or by grooves, much less should any considerable portion be removed.

There are cases occasionally in which the dentine is wholly decayed, and its removal lays bare the enamel; when such a case occurs, the enamel should be retained in as perfect a condition as possible, and no attempt made to form pits or grooves in it. The reason for this is found in the friability of the enamel.

It may be regarded as an axiom, that where it is necessary to cut the healthy dentine to give proper form to the cavity, it should be done at that part of the cavity where the tooth will suffer least from the loss. The precise point and amount of cutting will be determined by the form and size of the cavity, and the amount of solid dentine remaining after the decay is removed.

In small cavities where there is sufficient material

to work upon, the object is to give the cavity a regular form, and make the retaining points where it is most convenient.

In large cavities, where one side of the tooth is weak, places must be selected for making the retaining points, that will least affect the weak point. Frequently, in proximal decays of the anterior teeth, the labial and palatal walls are friable, and would be easily broken; much cutting upon such walls would not be admissible. Again, the decay often extends toward the point of the tooth, down to the union of the labial and palatal plates of the enamel; in cases of this kind, all that can be done at this point is to remove the decay; and fracture will sometimes occur even in accomplishing this.

In some instances, as in the crown cavities of the molars, the cavity will be nearly or quite of proper form when it is perfectly opened up, and the decay all removed. This is the case when the decay is confined to a simple perforation of the dentine, without any considerable lateral extensions. In proximal cavities there is always more or less excavation of the solid dentine required, to give the cavity proper form.

There is no definite rule for the formation of cavities, that will be applicable in all cases. The form will be modified by the tooth, the position of

the decay upon it, the extent and ramifications of the decay, and the manner in which it is to be filled. It is given, by some, as a rule, that the depth of a cavity should be equal to its least diameter. This is a direction, however, of no general application, for many cavities will be much deeper than the greatest diameter, as in crown cavities of the molars; and the reverse will often occur, as in labial cavities of the superior incisors, and in proximal cavities of the molars, in which it would be impossible to make anything like an approach to this rule, without exposing the pulp, and even cutting through its chamber.

A general direction, and one that we think good, and applicable in many cases, especially in crown cavities of the molars, and in almost any of the deep perforations by decay, is to make the walls of the cavity as nearly as practicable parallel with one another. This rule is applicable in almost all small cavities.

In medium or large-sized cavities, it is admissible to leave them slightly larger at the bottom than at the orifice, if circumstances require; a large cavity of this form can be perfectly filled, when a small one could not, from the fact that, in the former there is more room to operate in introducing, adapting and consolidating the filling.

Cavities that are larger within than at the orifice, should have their walls perfectly plain, smooth surfaces, free from transverse grooves or depressions, so that the gold may be accurately adapted to them.

It is sometimes necessary to leave a cavity slightly larger at the orifice than at the bottom. This may be done by a diverging inclination of the wall of one or more sides of the cavity. When there is an inward inclination of the wall at one side of the cavity, the general form may be such as to retain a filling perfectly, for there may be two opposite sides parallel, or even divergent; in that case, the axis of the cavity will not be in the direction of the centre of the crown.

Two opposite sides may converge and the others diverge, and a filling be retained firmly. When two contiguous sides have the same converging inclination, making the orifice larger than the interior, if the walls are smooth, plain surfaces, a filling will not be retained; but retaining points may be made by forming transverse grooves, or pits upon them, and by this means the filling be firmly retained. As a general rule, it will be necessary, when the orifice is larger than the cavity within, to make grooves or pits on the walls. For this purpose the diamond point excavator is invaluable.

If the cavity is large, and the walls near the orifice

thin, and liable to be broken, the situation of the grooves or under-cutting should be farther within the cavity than if the walls are firm out to the edge. Sometimes it is best to make little pits at the bottom of such cavities for retaining points. In cases where it is necessary to make an under-cutting, one or two little transverse grooves upon one side will be sufficient, and in no case on more than two sides, leaving the others perfectly plain surfaces.

In the formation of retaining points in difficult cavities, there is considerable diversity of practice—under-cutting and grooving have been very commonly employed. Another method in common use is that of drilling little holes or pits into the dentine at the most favorable points, these taking different directions. This kind of retaining points is much better calculated to answer the purpose, in filling with crystal gold, or cohesive foil, than with the ordinary non-cohesive foil after the old methods. When these perforations are made at different inclinations, and then perfectly filled with cohesive gold of any kind, the filling will certainly be retained in place. For making these perforations, a small square-edged drill is the proper instrument.

Such retaining points are seldom or never required in crown cavities of the molars; but in proximal cavities they are frequently employed with great

advantage. In forming them, great care should be exercised, lest the pulp-chamber is encroached upon by the instrument. In almost all cases, the proper point for forming them is in the cervical wall of the cavity.

Some operators discard any definite retaining points, grooves, or angles, but aim, instead, to give a general retaining form to that part of the cavity in which the filling is to be commenced, and upon which reliance is to be placed for its retention. The advantage of definite retaining points is two-fold : first, to facilitate the introduction of the filling ; and second, its more certain retention after it is in position.

Another particular to which attention should be given is the border of the orifice. It should always be an object to secure an *even*, *smooth* and *strong* border to the orifice of the cavity. It is impossible to make a good finish with a rough, uneven border ; the filling is also more exposed to injury by mastication. The integrity of a smooth, plain surface is retained under influences that would break up and destroy an uneven one. It is also very desirable to have a *firm* margin ; to obtain this, it is often necessary to cut away more than would otherwise be desirable. A smooth, firm border should not be sacrificed for the form, and especially in the posterior teeth. It is very objectionable to some persons to

have the perfect form of the front teeth marred or changed; but it should be remembered that even a front tooth one-third cut away, and so filled as to be permanently preserved, is far more valuable than an artificial one.

Another particular that should always be observed, is, to obviate all acute angles, and especially when they are in the vicinity of the orifice of the cavity. These are seldom or never found in proximal cavities of the molars and bicuspids; occasionally they are found in proximal cavities of the cuspids, and frequently in proximal cavities of the incisors, particularly at that part of the cavity next to the cutting edge of the tooth. Such angles are very often found also in crown cavities of the molars and bicuspids, where there is an extension of the decay along one or more of the fissures of the crown.

It is difficult—almost impossible—to fill perfectly a sharp angle, and hence the necessity of obliterating such when it occurs. This may be done either with a small delicate cutting instrument or with a small bur drill. It is an operation requiring great care and delicate manipulation, at least so far as the anterior teeth are concerned. When a sharp angle occurs in the proximal cavities of the front teeth, it is usually near the cutting edge of the tooth, just at the union of the labial and palatal plates of

enamel. A small chisel-shaped instrument is very good for cutting out such angles: indeed, in fissures of crown cavities of molars, where the decay extends backward, the straight, chisel-shaped instrument is just adapted to this purpose; but when there is an anterior extension, the instrument should be curved to almost a right angle, and forced down by pressure of the thumb of the left hand. The small burs and fissure drills represented by Figs. 20 and 22, used with the dental engine, will meet the requirements in such cases with great facility. Some good operators recommend a slight reaming at the orifice of all cavities, where it can be accomplished. The object of this is two-fold: to remove the sharp angle at the orifice of the cavity, as it is liable to be fractured or roughened in putting in the filling; and to give a better margin to the filling. In making this bevel, the bur, if one is used, should be but little larger than the orifice of the cavity. The cutting should be but slight—just sufficient to remove the sharp corners; much cutting here would give too thin and yielding an edge to the filling.

EXCLUSION OF MOISTURE.

The complete and certain exclusion of saliva and all moisture from a tooth that is to be filled, has

ever, till within a comparatively recent period, been a great desideratum. A great many appliances and methods have been employed for the accomplishment of this object. The usual method was to pack about and around the tooth upon which an operation was to be performed napkins, bibulous paper, spunk, etc., retained in place by holders. These, in most cases, were effectual but for a short time, and when the flow of saliva was abundant, constant vigilance and effort were necessary to secure the proper exclusion of moisture. Quite a variety of instruments and appliances have been employed for holding in place these various paddings. Some of them were to be held by the patient, others were so formed as to clamp the rolls or pads firmly in place.

None of these appliances had reference to checking the flow of saliva by compression upon the mouths of the ducts; this, however, in due time was introduced. Various appliances and adjustments were made with this object in view. Pads of cloth, bibulous paper, spunk, and disks of pipe clay, were the principal things used for this purpose; they were placed and held firmly on the mouths of the ducts by clamps, springs, &c. A good degree of success was in this way attained in some cases, in others it is impossible to close all the ducts; and in almost every instance these things stimulated an excessive

flow of mucus. Filling the mouth in the manner just described was always objectionable to the patient, and in many instances could not be tolerated.

In addition to all these things, various pumps were devised for removing the saliva from the mouth as it accumulated, all of which were more or less objectionable.

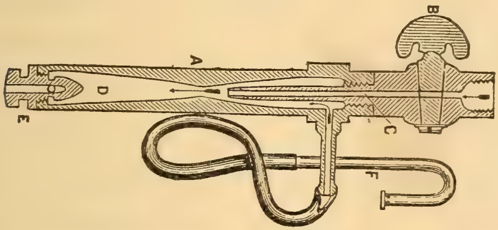
All these modes and appliances have been superseded by the introduction and use of the rubber dam and saliva extractor. For the former of these the profession is indebted to Dr. S. C. Barnum, and for the latter to Dr. J. E. Fisk.

The rubber dam is, by all those who understand its use, justly regarded as an invaluable boon. It can in any and all cases be applied so as to absolutely exclude moisture from a tooth or teeth while being operated upon. It does not, however, prevent the free flow of saliva into the mouth, and in most cases this occurs to a very objectionable extent, and either the patient must swallow it,—and with the rubber dam in place very few can do this,—or it must overflow from the mouth, which is very unsightly, inconvenient, and annoying, or it must be drawn from the mouth.

About three years ago, Dr. Fisk made available the principle of the Gifford injector, devised the saliva extractor, a very valuable appliance indeed;

one that with a constant stream of water performs its work perfectly. The following cut gives a sectional view of it.

Fig. 72.



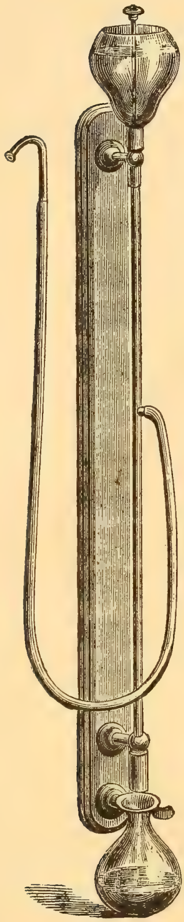
An instrument constructed by Dr. George B. Snow for the same purpose gives promise of great usefulness. In principle it is a compromise between the Gifford injector and the syphon. It requires for operation but a small amount of water—about one quart per hour. The water requisite for its working is contained in a reservoir holding about two quarts.

This instrument is very efficient and uniform in its operation. It is shown in Fig. 73.

With either of these appliances, the mouth can be kept for any length of time entirely free from any excess of saliva.

The rapid, easy and efficient application of the rubber dam is not attained without some manipulative skill and experience. It is prepared for dental purposes of three or four grades, in respect to thickness; the thinnest is about as thick as a sheet of

Fig. 73.



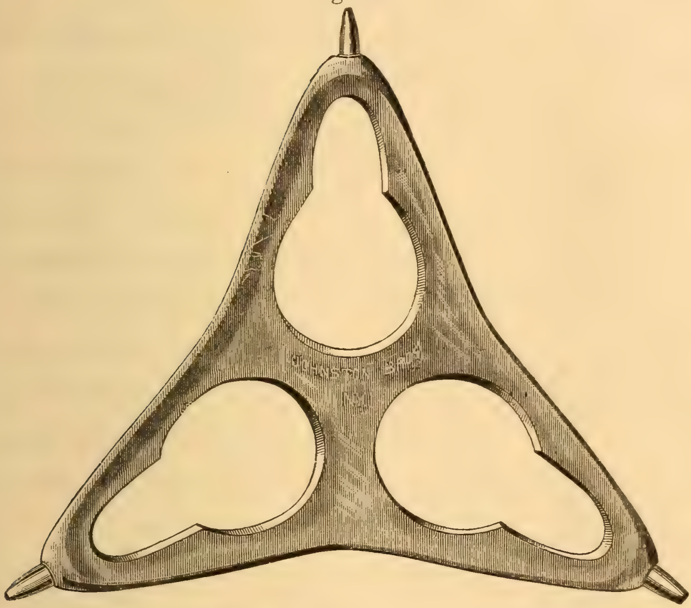
common commercial note paper; the other extreme would be represented by about six-ply of the same paper.

This web should be made of rubber of the finest quality, and free from all foreign substances. Having selected that of the desired thickness, cut a piece six inches wide and from six to ten inches long; select the proper place or places for perforating it for the teeth; for this, three sizes of punches will be required: one about a line and a half in diameter, for the molars; one about a line in diameter, for the superior incisors and bicuspids, and one half a line, for the inferior incisors, and sometimes for small superior incisors.

These punches are shown in Fig. 74. The distance between the holes in the cloth should be from one line to two lines and a half, governed by the distance between the necks of the teeth to which it is to be applied.

The following accessories should be at hand and ready for use before beginning its application to the teeth:

Fig. 74.



Silk Thread.—That known as surgeons' or saddlers' silk is well adapted to the purpose. There should be at least two sizes of this.

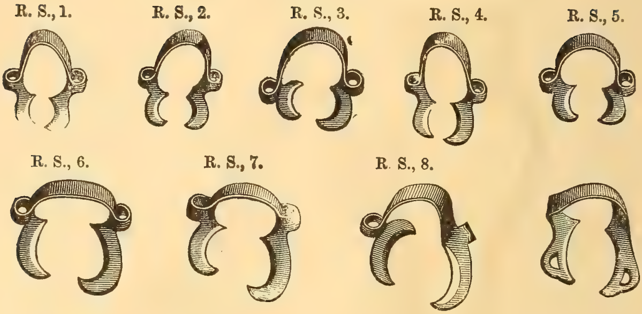
For some cases the floss silk is better adapted than the thread. These should always be at hand.

The clamps for rubber dam are indispensable; they are of various forms and sizes, and are now made adapted to all the teeth; and in addition there is quite a number of extras for special cases.

The following cut represents the set for the superior teeth of the right side, each of which has been formed and adapted to the respective tooth upon which it is to be used.

There are in the full set thirty-two, and a few for

Fig. 75.



special cases, thus making by far the most complete and efficient series of these clamps ever devised.

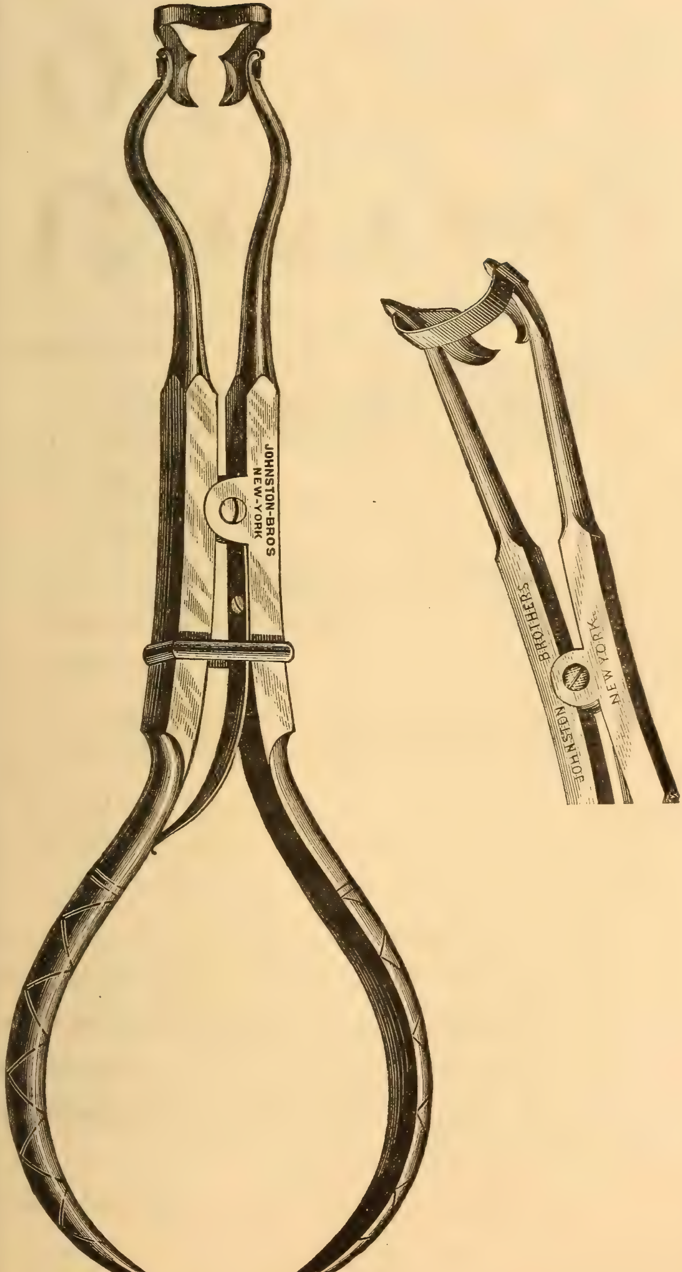
The profession is largely indebted to Dr. Delos Palmer for the most efficient clamps that have been in use for several years, and wholly indebted to him for the very perfect set represented above.

The clamps are usually placed on the teeth, after the rubber-cloth is drawn over them, for the purpose of retaining it in a proper position. Oftentimes, however, the rubber may be drawn over the clamp, and then both together be placed upon the tooth. This method is usually employed only when one tooth is to be protected.

For this adjustment upon the teeth, *clamp-forceps* are in requisition. They are so formed as to pass into the curve of the clamp, and by pressure upon the handles, open it sufficiently to pass on to the crown of the tooth, the rubber then being drawn under the jaws of the clamp.

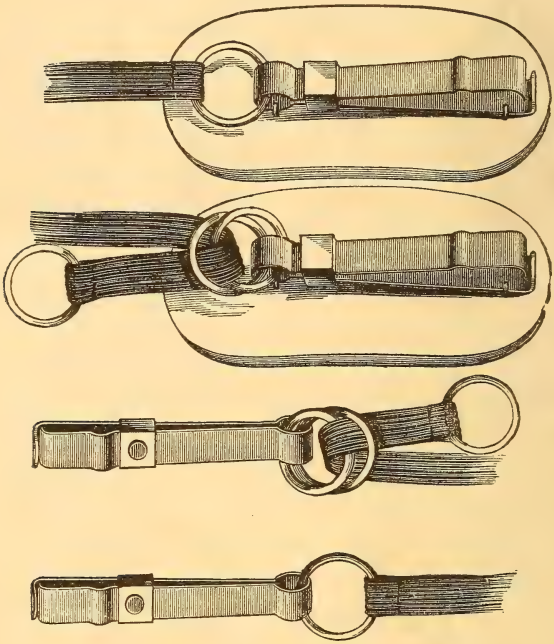
Fig. 76 represents the clamp-forcep in common use.

Fig. 76.



The elastic strap, with clamps or catches attached, is necessary for holding away the upper free portions of the rubber-cloth (Fig. 77).

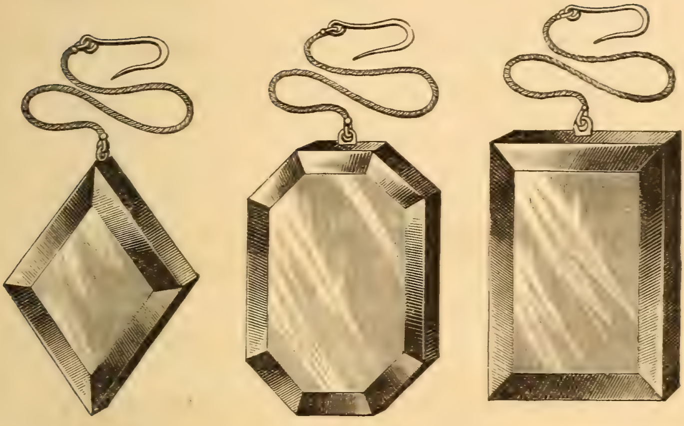
Fig. 77.



The weights, also, for holding out of the way the lower free portions of the rubber-cloth, are important. These are shown in Fig. 78.

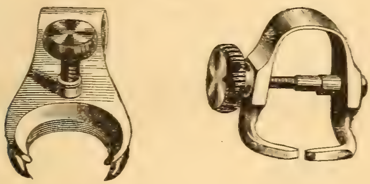
Various sizes and forms of *wedges* will be required; these should be prepared beforehand, or they may be made at the time they are to be used; their adaptation to the peculiarities of the case in hand rather favors this course.

Fig. 78.



Jarvis separators should always be at hand, to press apart any teeth that may stand so firmly in contact as to prevent the rubber from passing readily between them.

Fig. 79.



Having now come to that point when the rubber-dam is to be applied, various questions and considerations occur:

First.—Upon how many teeth shall the dam be placed?

The character of the operation will determine this. For a simple crown cavity of either a superior or

inferior molar, if the opening of the mouth is capacious, the embrace of one tooth may be, and often is, sufficient. If, however, the mouth be small, or the tooth unfavorably located, two or even three teeth should be included, even for such a cavity as just indicated. For filling proximal cavities, two or more teeth should always be included, and more frequently three or four. The difficulties liable to occur from the embrace of an insufficient number are: encroachment of the cloth upon the locality of the operation (the size of the mouth and its behavior will modify this, however), and the liability of leakage about the last teeth included in the embrace.

A sufficient number should in every case be included to meet the requirements, and no more. The practice of placing the rubber upon eight or ten teeth, when two or three at most would be sufficient, should not be encouraged or allowed. It is a waste of time for the operator and an unnecessary annoyance to the patient.

In the application of the dam, if it is to be put upon two or more teeth, it should first be placed upon that tooth which is most accessible, then upon the next one, and so on till all the selected ones are included. As the rubber is drawn over the crown of each tooth, the thread or floss should be passed between it and its neighbor, carrying down to the

margin of the gum the rubber that is between the holes; this process should follow the application of the rubber to each tooth.

The rubber will often pass with difficulty between the teeth, either because of firm contact or because of roughness upon the proximate surfaces of the teeth, the latter sometimes causing tearing of the rubber. To meet the former difficulty, the separators (Fig. 79) may be used, and sufficient space readily obtained to afford an easy passage between the teeth, and a very thin saw for the removal of the roughness; this, however, should never be applied to the perfect surfaces of the teeth; and in respect to the rubber, moistening it with a solution of fine soap, of proper consistence, will greatly facilitate its passage between the teeth.

The rubber cloth now being upon the teeth, the elastic band with its clasp should be attached to the upper free border at each side, and drawn round the head sufficiently to keep them out of the way; then the thread, in connection with a small, properly-formed instrument, will be applied for turning the border of the rubber about each tooth down beneath the margin of the gum, the thread accomplishing this between the teeth and the instrument, at the labial and lingual surfaces. This is a part of the work that should be carefully and thoroughly performed; the

absolute exclusion of the moisture depends much upon this. Ligatures are sometimes tied tightly round the necks of the teeth, for the purpose of holding the rubber in place about them.

After this, the wedges, if required, should be introduced. The objects to be gained by these are: increase of space between the teeth; to retain the septum of the rubber against the gum, and press the gum up somewhat, and thus effect greater security against the encroachments of moisture; and to protect the gum from injury by the instruments which are to be subsequently used.

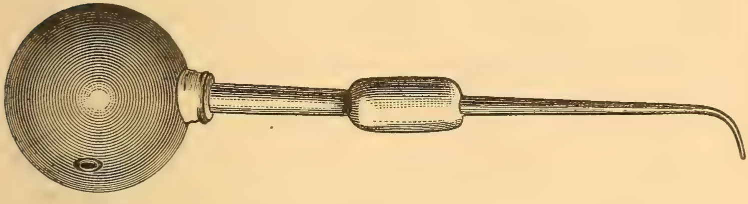
The weights should now be applied to the inferior borders of the rubber, in such a manner as to keep them in a desirable position. With the rubber dam thus adjusted, and the "saliva extractor" in proper order and in place, there will be no difficulty with moisture or an overflow of saliva in any case, and the succeeding steps may be conducted with the utmost security, so far as moisture is concerned.

Some operators apply the rubber dam in almost every instance prior to the removal of decay and the formation of the cavity for filling; and doubtless in many cases it is the preferable course, the only objection to it being the prolonged inconvenience to the patient; but for this there is perhaps full compensation, in the greater facility afforded in the

removal of decay from and the excavation of the cavity; with the entire absence of saliva and moisture, the work can be effected with greater rapidity and precision; improper cutting is less liable to occur.

After the rubber dam is properly adjusted, it is an easy matter, with bibulous paper or some similar substance, to render the tooth and the part to be operated upon thoroughly dry. Every particle of debris, cuttings of dentine, etc., should be removed from the cavity before it is filled. This removal may be effected by the small scoop-shaped instruments, of which there should be three or four sizes. In connection with these, the "*chip blower*," or warm air blowpipe, illustrated in Fig. 80, may be advantageously used.

Fig. 80.



This instrument consists of a small blowpipe, with a cylinder an inch long and half an inch in diameter; this is placed down within two inches of the point of the instrument. This cylinder is either made of very heavy metal, or filled with wire or something that will retain heat; on the other end is attached a

stiff India-rubber ball, with an eyelet opening, one-fourth inch in diameter. By placing the thumb upon this opening and making compression, a jet of air is forced through the point of the pipe, and the cylinder being previously heated, the temperature of the jet will be governed by that of the cylinder, and the velocity with which it is forced through the instrument. This jet thrown into a cavity that has been made as dry as possible by wiping, soon makes a very perceptible change, the walls becoming whiter than before. This we consider the most desirable condition in respect to dryness that can be obtained.

INTRODUCING THE FILLING.

Having in all these steps for the preparation of the cavity made thorough work, the next thing to be accomplished is the introduction and consolidation of the filling. The manner of performing this part of the work will be governed by the kind of material employed, and also, somewhat, by the form of the particular material, as well as the method adopted. Some materials, as gold, for instance, may be used in six to eight different forms, each involving a principle peculiar to itself; and each of these forms is susceptible of being used in different ways. It is proposed to describe, as clearly and concisely as

possible, the various methods of filling that have been found efficient. This is the more important since different operators differ in their election of methods; some preferring one, others another,—the result of mere choice, habit, or some peculiar fitness.

The first method for consideration is that of filling with ordinary non-cohesive gold foil. The principles applicable to the use of this kind of foil also obtain in the use of foils of other metals. Gold is used far more than anything else. The common, and, indeed, the almost universal method of using foil, in the early periods of the profession, was in the form of a roll, or rope, as it is sometimes called. By this method the foil is cut into strips from one-third of an inch to two inches wide, the width being governed somewhat by the size of the cavity to be filled. This strip is then rolled lengthwise, forming a loose roll. The compactness of the roll should depend upon the thickness of the foil, and the size of the points with which it is to be condensed; the smaller the points, the more compact the roll may be.

It may be introduced either with the condensing instrument or with the plugging pliers. If with the former, it is taken up at one end on the point of the instrument, and passed to the bottom of the cavity; and that portion within the cavity is then pressed firmly against the wall where it is desirable

to begin the filling. There is no definite uniform point in cavities at which to begin the introduction of the gold; usually, however, in crown cavities of the molars, at the posterior wall. At whatever point the filling is commenced, the cavity should be so formed that it will retain in position the first portion of gold introduced; and this may be done by forming a little pit or groove for its reception. This is a particular that cannot with impunity be neglected. The gold should never change its position after it is pressed to the wall of the cavity; for its position cannot be changed, except at a sacrifice of the adaptation, after it is condensed. The end of the roll being placed in the cavity, it is seized far enough without the cavity to form a fold that will extend to the bottom, and protrude about one line beyond the border of the orifice. This fold is pressed firmly upon the preceding portion of gold and adjacent walls. Thus fold after fold is introduced, passed to the bottom of the cavity, and, protruding from the orifice, consolidated firmly; each portion as it is introduced should be well adapted to the walls of the cavity and the preceding portion of the filling.

It is important to obtain as complete an adaptation of the filling to the walls of the cavity as possible; and in order to accomplish this, the centre should not be filled too rapidly. The gold is thus introduced

fold after fold till the cavity is full. When it is filled to two-thirds of its diameter, the gold should then be adjusted to all the remaining walls of the cavity, and the last portions of gold introduced somewhere in the body of the filling, certainly not next to any wall of the cavity. A more thorough adaptation of the gold can be made to the walls of the cavity by this manner of arranging it than by introducing the last portion at one side of the cavity. There is less liability of fracturing a frail tooth by placing the gold on the walls first, and terminating the introduction of it at or near the centre of the filling. It is the practice with some to introduce the gold rather loosely, or without much condensing, and after being introduced in this manner, to condense by forcing into it a wedge-shaped instrument at various points, and filling these perforations with small rolls of gold, continuing to use the wedge-shaped instrument as long as it can be forced into the filling. This method is by no means as efficient as that of condensing each portion as it is introduced. By the latter plan the filling can be made uniformly dense from the surface to the bottom. This cannot be done by the use of the wedge-shaped instrument; it will compress most at its largest diameter, that is, at the surface of the filling.

In no filling, even when the walls of the cavity are parallel, will a uniform density throughout be ob-

tained by perforating with the wedge-shaped instrument. The filling would be most dense at the surface, and gradually less so all the way to the bottom. This method is objectionable for condensing the fillings on the masticating surfaces of the molars; for in the act of mastication the inner portion would yield, the surface of the filling would be crowded down into the cavity, and the dentine within the orifice become exposed, and decay be the result. In proximal fillings, this objection would not have the same force. In pressing an instrument of a wedge form into a filling with sufficient force to condense the mass, there would be great danger of breaking a weak wall of the cavity. The principal pressure is lateral, and would consequently come upon the side of the tooth.

In crown cavities of the molars, where there is any considerable inward expansion of the cavity, that method of condensing would be wholly inefficient; it would not render the inner portion dense enough to support the surface of the plug, and it would be forced down, and necessarily be loose. In filling the proximal cavities of the incisors, it is very objectionable on account of the great liability of breaking the inner and outer walls, which are usually quite thin.

In preparing the foil for filling, some operators tear off the foil in irregular pieces, and form these

into little balls or pellets, round and loosely rolled, corresponding in size with the cavity to be filled. These pellets are placed in the bottom, if a crown cavity, and at one side if a proximal cavity, and condensed with a sharp-pointed instrument, attaching one pellet to another till the cavity is full. This mode is not so good as that previously referred to, unless the gold is in a condition to weld perfectly; there is no continuous portion from the bottom to the orifice of the cavity, and the outer portions are liable to become detached. Both of these methods of arranging the gold are objectionable in one particular, namely, the irregularity of the leaves or laminæ of the foil; these are placed in the cavity without regard to regularity, and the consequence is that, without great care, far less gold will be introduced than by some other arrangement. Much more difficulty is experienced in obtaining a uniform and equal density than when the laminæ are placed smoothly together.

Another method of preparing the foil is to fold it into from four to twelve thicknesses, then cut off strips in width corresponding to the diameter of the cavity. The strip thus prepared is introduced in the same manner as the roll, except that as each fold is inserted, it is placed smoothly against the preceding portion, and kept smooth and free from wrinkles.

By this arrangement very little force is required to bring the folds in perfect contact. Some care and skill will be necessary to bring the instrument to bear upon the whole surface of the fold. More gold can be put into a cavity in this manner than in rolls or pellets, unless these are used in small portions, and condensed thoroughly as they are put in.

CYLINDER OR BLOCK FILLING.

Another and in some respects far preferable method, is filling with cylinders or blocks. Some of the advantages of this method over that just described are the following: the filling can be introduced far more rapidly; and the laminæ, or leaves of foil, take a more perfect position in the cavity, and consequently the structure of the filling is better. The form of the cavity should be much the same as that for any other method of filling; there should be some retaining point so situated that the first block, or blocks, can be fixed firmly in place, so that there will be no liability of loosening during the subsequent part of the process. It is important to have such an arrangement, as otherwise it would be necessary to employ an instrument in the left hand to retain the first blocks in situation, till enough were introduced

to bind the whole by pressure upon two opposite points in the cavity.

Forming Blocks.—For forming blocks, use any number of foil that may be desired, usually No. 4 or 6, and either lay four to six sheets together, or fold a single sheet into that number of thicknesses; then cut off from the sheets thus prepared strips about one-third to one-fourth wider than the depth of the cavity to be filled; these are then rolled on a small three or four-sided broach—the three sided is better. This instrument should be very small—no larger, indeed, than is necessary for strength. Its sides should be perfectly smooth, and its angles sharp; ordinarily it should not taper, or at least but slightly. For forming the conical blocks, some prefer the tapered broaches, but they can be as well made on the parallel-sided instruments. The strip being taken between the thumb and the index finger, is rolled on the broach equally, till the block or cylinder is large enough, when the strip is broken off. The size of the principal part of the blocks should be determined by the size of the cavity to be filled. Different sizes and forms will be required in almost every case. Relatively large cylinders may be employed for the principal part of the filling. If the walls of the cavity are parallel, almost all the blocks may be cylindrical; but if there is an under-dipping of one

or more of the walls, the blocks adjusted to that particular part should be cone-shaped, corresponding to that under-dipping. A number of small graduated cone-shaped blocks, of different degrees of density, will be required for completing each filling; as the aperture becomes smaller, smaller blocks will be needed. The cone-shaped blocks are formed by gradually running the strip back from the point of the instrument as it is wound on; greater or smaller taper can be given to it as the strip is run less or more rapidly back from the point. The density of the block can be regulated by the firmness with which the strip is held between the thumb and finger, upon which it is well to have a suitable covering, to protect the gold from the perspiration of the hand. There are other methods of forming blocks. Cylinders and blocks are prepared by foil manufacturers, but they are not made in sufficient variety, in respect to form and density, to meet all cases; but they should always be at hand, and any deficiency may be supplemented by the dentist. They may be made square, by making a great number of folds—fifteen to thirty—and from this cutting strips as before directed, and then from these heavy strips cutting off the blocks of the desired size, which will then be flat or nearly square. In one respect these blocks are objectionable. The edges when they have

been cut off are rendered dense by the action of the shears, so that they do not possess the uniform density or consistence of the rolled blocks or cylinders, and it is impossible to adapt them as perfectly to the walls of the cavity, or to one another. This objection, however, may be obviated by cutting off the blocks with a very fine saw.

Another method of forming blocks is to roll a sheet of No. 5 foil into a rope, and cut off from it blocks corresponding with the size of the cavity to be filled. These are liable to the same objection as those last mentioned, the shears hardening them when they are cut off. They are subject to the additional objection, that the folds of foil are not as regular as by either of the other methods. But by proper manipulation, with the gold prepared in this manner, superior fillings may be made. Another method of preparing blocks is by cutting a sheet of foil into two or three pieces, then rolling them diagonally on a steel wire or rod; the size of this wire will be determined by the required length of the blocks; as there should be blocks of different lengths, the wires should be of different sizes, and range from No. 2 to No. 12 of White's bur gauge plate. The size of the wire will be determined by the depth of the cavity. The wire being withdrawn, the roll is compressed to a strip. These strips are now rolled squarely upon a No. 20

steel wire, the size of the cylinder being determined by the size and form of the cavity to be filled. These may be used either in their cylindrical form or compressed and doubled. The cavity formed and the blocks prepared, the next step is their introduction.

Introducing the Blocks.—For placing the gold into the cavity, the plugging pliers are required, the points of which should be curved, so as to make the most direct approach to the cavity. The points, too, if properly formed, may be used to some extent for condensing the blocks. All things being ready, the cavity secured against the encroachment of moisture from the saliva and breath, the left hand should be employed to keep the rubber and the soft parts of the mouth in position. If there is an angle, a small block should be first introduced with the pliers into the proper position, one end upon the bottom of the cavity, and the other protruding from the orifice, and pressure then be made to consolidate it, and force it into its position against the wall of the cavity. This may be done with the pliers, or better with the instrument represented by Fig. 34. The part of the instrument brought to bear upon the gold should be roughened either longitudinally or transversely, so that a proper surface may be left for the reception of the succeeding portions. The largest blocks are then

introduced and consolidated successively as described, the end of each left protruding till the cavity is filled; each portion as it is introduced should be perfectly condensed. The gold should be filled in faster at the sides of the cavity than in the centre, thus being disposed round the walls till it meets at a point opposite the place of beginning; and thus the gold is adapted to all the walls of the cavity before it is entirely filled, the last portions being introduced somewhere near the centre of the filling. As the cavity diminishes by the introduction of the gold, the small and more dense blocks will be required; these should be forced in and condensed, by crowding the instrument (Fig. 36) down against the side of the cone. Some operators terminate the filling against the wall of the cavity, forcing down the blocks and compressing, as above, till it is full. By this method there is danger of fracturing the tooth, breaking down the wall of the cavity, where the filling is terminated. Another method is to fill up the cavity principally with blocks, and to put in the last part of the filling in the strip, filled in from the bottom to the orifice. The objection to this method is, that unless adhesive foil is employed, the portion inserted in the strip is liable to be displaced, and in this way the whole filling become destroyed.

Another method of arranging this kind of filling,

particularly when the bottom of the cavity is irregular, is to make a large, flat pellet, condense it firmly to the bottom, and set the blocks upon this for a foundation. By this method there is a more perfect adaptation of the gold to the bottom of the cavity, than by placing the ends of the blocks down upon an uneven surface. After the gold is all introduced, a small-pointed plugger must be passed over the entire surface, to consolidate the protruding portions. These protruding portions should be sufficient to make the surface, after being condensed, perfectly flush with the border of the cavity, for a depression here is fatal to a complete finish. After the condensation with the finely-serrated points is accomplished, then the blunt, smooth, polished points should be used with the mallet all over the surface of the filling, then the files, burs, stones, &c., of the various grades should be used to complete the finish.

Dr. Badger described a method of filling a small cavity on the posterior proximal portion of a second molar, the third molar gone. The cavity is formed with a bur drill. A cylinder is then formed in the usual manner, and forced through a series of holes in a drawplate, down to the size of the bur with which the cavity is prepared. The block is thus rendered quite dense. The cavity is then dried, and the block forced into it, which it exactly fits, protruding a little

from the orifice. This block is pierced in the centre with a sharp instrument, and a small dense roll forced into it; all is then condensed, and finished in the usual manner.

Pellets.—Pellets made by rolling fragments or pieces of foil between the thumb and fingers are used by some operators, and with them they profess to make as good filling as by any other method. They are made of various sizes, and packed into the cavity with sharp-pointed or serrate-pointed instruments. The pieces may thus be very solidly worked together, and a good filling made, provided the pellets are not too large; they should be small enough to permit the point or points to work through them into the preceding portions. Some operators use pellets and crystal gold together. This may do very well if the cohesive property of the gold is employed; but in that case, either form of the material would answer alone. There cannot be as much gold put in by pellets as by blocks or cylinders well adjusted.

Cohesive Foil.—By this we understand that condition of gold foil in which the leaves unite readily and firmly together. This property of cohesion is possessed in the greatest degree by properly manufactured foil, immediately after annealing. Not that annealing imparts any new property to the gold, but it removes obstacles to the manifestion of a prin-

ciple possessed by all gold under favorable circumstances. It is now about twenty years since this property was first employed in gold foil for filling teeth. To Dr. R. Arthur is due the credit of first directing the attention of the profession to it, as being available for filling teeth. He not only did this, but he entered most fully into the details of the manipulations, instruments, etc., pertaining to this mode of operation. Almost all recently-prepared gold foil possesses this property to a greater or less degree; there are methods of preparing it, however, by which it possesses it most fully; all recently-annealed foil is cohesive. If the foil is in this condition when we wish to use it, nothing further is required in the way of preparation. But if it is not cohesive,—as almost all foil is not, especially if it has been much exposed to the influence of the atmosphere,—it will require to be made so by some process. There are two methods, either of which will well accomplish the object.

The one most frequently employed is that of heating the gold, either in the sheet, in the roll, or in fragments, over the flame of a spirit-lamp, almost or quite to a read heat; if in the sheet, it should be laid upon a piece of wire gauze, and passed over the flame of the lamp for a moment or two; if in the roll, it may be taken in the centre with fine pliers

and passed rapidly through the flame. But if the gold is in the form of pellets, blocks, cylinders, or small pieces of any shape, it may be taken up with the pliers and passed rapidly through the flame of a spirit-lamp, till all foreign substance is burned or driven from it. Or it may be placed on a sheet of mica, which is adjusted over a flame, and then brought to a proper temperature.

There are different methods of using gold in this condition; but in general the cavity should be formed about as for the other methods of filling, except that to retain the first piece, there should be two or three small pits or holes made for retaining-points in the most available position. The first portion of gold should be a little pellet; this, forced into these retaining-points, serves as a foundation for the remaining portion of the filling. Dr. Arthur's method is, then, to tear off fragments from the sheet, and pass it into the cavity without folding up, and condense it with an instrument of finely serrated point, so that it not only unites by cohesion, but is worked into the surface of the preceding portion of gold; and in this manner portion after portion is introduced and condensed, until the cavity is full. The filling may be commenced in any part of the cavity that is most convenient; in many, as in crown cavities of the molars, at the bottom, and filled to the orifice. In

putting in the gold, it should, during its introduction, be kept fuller about the walls of the cavity than in the centre; by this means the adaptation will be most perfect to the walls, and there will be no liability of clogging in the centre. The gold may thus be built up to any desired extent if the filling is kept dry; moisture is fatal to its cohesion.

Others use the cohesive gold in a different manner. To Dr. Blakesley belongs the honor of first detailing the following plan: The sheet of gold may be folded or not at the pleasure of the operator, and then each sheet cut into from two to six strips, and each of these formed into a loose roll between the thumb and fingers. These should now be passed through the flame, as already described, then cut into little blocks or pellets of various sizes; these to be regulated by the size of the roll and the cavity to be filled. For the introduction of the gold thus prepared, about three sizes of instruments are required, those having finely serrated points being preferable. As to the sizes of these points, Dr. Blakesley remarks, "They should just enter respectively Nos. 22, 24, and 26 of the wire-gauge." A larger than either of these, however, is desirable for many cases. As before, the filling may be commenced at the bottom of a cavity, or at one side, if desirable, with a pellet sufficiently large to be set firmly into the re-

taining pits. Then take up the small pellets or blocks upon the point of the plugging instrument, and place them exactly in the desired position, and consolidate them thoroughly, building up next to the wall all around higher than the centre, with the smaller pieces, filling up the little corners and interstices, for which manipulation the smaller points will be required. The gold is then packed in till the cavity is full, when it is finished as usual. Another method is to tear off fragments from the sheet, and roll these up into round pellets, and fill with these, with the same instruments and upon the same principle as above described. But by this method it is difficult to make a perfect filling; the gold is liable to clog in the cavity, and fail in adaptation.

Cohesive gold must be consolidated as it is introduced; for if a cavity is full, it is very difficult then to condense it more, even though the consolidation is but partial; and the same is true to some extent of non-cohesive foil.

THE MALLET.

In the year 1860, Dr. W. H. Atkinson introduced to the dental profession the mallet for the purpose of condensing gold in filling teeth. This effected quite a change in the theory and practice of

this part of the work. Prior to this period it was accomplished entirely by the pressure or force exerted by the hand. There was very considerable diversity of opinion as to the best mode of this manipulation, some maintaining that great force is always required to make a filling sufficiently dense,—assuming that it is better to use comparatively large points, great pressure and rapid execution, thus securing the utmost economy of time, both to the operator and patient. Others entertain the opinion that with smaller points, less pressure, and greater time, a more definite and satisfactory result is attained.

Notwithstanding the diversity of opinion and practice upon this subject, we would suggest that young operators, at least, should bear in mind that in so important a matter as filling teeth, efficiency should never be sacrificed to rapidity.

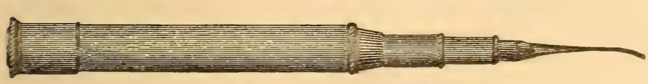
This method is especially applicable and effective for the condensation of cohesive gold, and indeed gold in any form, when the aim is to condense each portion as it is introduced. A more thorough condensation is made by the use of the mallet than is possible by the hand alone; greater precision of manipulation is attainable; it is easier for the operator, and usually less unpleasant to the patient.

The character of the results in the use of this instrument depends much upon the skill of the

assistant. It requires time, care and patience to familiarize an assistant with the use of the mallet. The plugger should be held firmly in position by the operator, and receive the stroke squarely upon the end ; it should be a sharp, springing tap. Very much depends upon the character of the blow; a dead, heavy stroke will not unite the gold as it should be. It is important that the assistant be able to follow the indications of the operator without loss of time. Many assistants are disposed to give time strokes instead of following indications, which are not admissible except in very simple cases.

In order to avoid the employment of an assistant, and to place the strokes of the instrument more under the control of the operator, various forms of automatic mallet pluggers have been invented and constructed. Two or three principles embrace the whole, though many different forms have been made. Those operated by the action of spiral springs have been the more common; the objection to almost all of

Fig. 81.

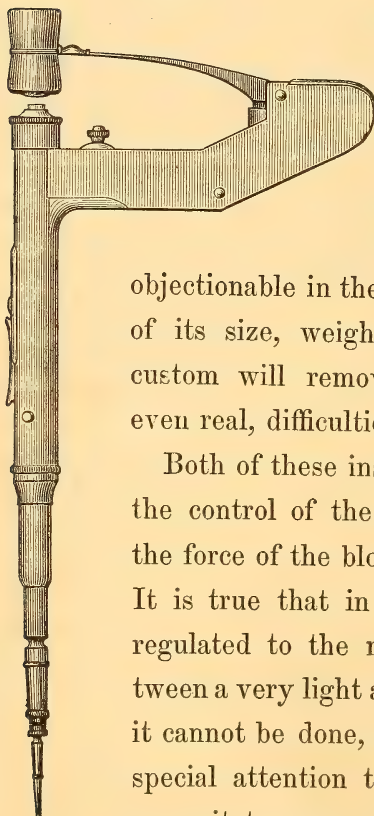


these is, that the stroke lacks the desired elasticity. This class of instruments is represented in general aspect by Fig. 81.

This instrument was invented by Dr. I. A. Salmon, and is one of the best of this form; it operates well in the hands of those who become familiar with it.

Another form of mallet plugger is represented in Fig. 82, in which the blow is communicated by a spring of another form, and of such an arrangement as to give an elastic stroke. This instrument was invented and made by Dr. W. G. Redman. It would be objectionable in the hands of some, because of its size, weight and form. Use and custom will remove great apparent, and even real, difficulties.

Fig. 82.



Both of these instruments are less under the control of the operator, in respect to the force of the blow, than they should be. It is true that in both the force can be regulated to the most minute degree, between a very light and a very strong stroke; it cannot be done, however, without giving special attention to that particular, which necessitates an arrest of the operation of the instrument.

An instrument is made by Dr. S. B. Palmer, in which the force of the blow is placed completely under the control of the operator while it is being used. The operation of this instrument is perhaps less objectionable, in respect to the character of the stroke, and its control by the operator, than any other as yet employed. Any of these instruments are valuable in the hands of those who become familiar with them.

During the last few years efforts have been made to operate the mallet by various motors. The first attempt in this direction was by Dr. G. W. Bonwell, by the application of galvano-electricity. The first machines were very crude and unsatisfactory; but by improvements made from time to time, the instrument is quite efficient in the hands of those familiar with it.

A mallet has been invented and constructed by Professor T. L. Buckingham, designed to be attached to and operated by the dental engine. It is more under the immediate control of the operator than most of the automatic mallets in use. This is highly prized by many. The pneumatic mallet was devised by Dr. W. H. Jackson. This consists of an ingenious and yet simple application of air as a motor. For a description of each of these, with illustrations, see Appendix of this work, Sec. C.

CRYSTAL OR SPONGE GOLD.

The form of the cavity for crystal gold filling should be much the same as that described for other fillings, except that the same care is not necessary for special retaining-points; for the first portion of good crystal gold that is introduced into the cavity will attach to the walls without any such provision. Such a form should be given, however, as to secure the first piece firmly in place. The gold should be cut or broken into pieces corresponding in size to the cavity, so that they will enter freely into it.

The filling may be commenced upon the bottom of the cavity, or upon one of its sides; such a point always being selected as will most effectually retain the gold in place. The pluggers should be of various sizes—the first one as large as can be used freely in the cavity, and smaller ones for condensing more thoroughly; and all should be serrated. The blocks may be taken up on the point of the plugger, or perhaps better with the pliers, and passed to the proper position in the cavity, and there condensed. The sharp serrated point leaves the surface in good condition for the reception of the next piece. The gold should be packed to the walls of the cavity a little in advance of the centre, so that its adaptation may be more complete. In this manner the filling is

built up as much as is desirable, if it is kept dry,—and unless it is, cohesion is very much diminished, or lost altogether.

The gold, after it is cut up, is passed through the flame of a spirit lamp, to anneal it, and dispel all foreign substances. It should in no case be brought above a perceptible red heat, and usually not to that point; it should be done carefully, so as not to fuse any of the particles, as that would impair their facility of cohesion in this process. Small portions are often required to fill up small interstices, or notches.

In crown cavities, the filling should begin at the bottom; in proximal cavities, at the cervical wall. By introducing the gold in this manner, the pressure is made on a line with the axis of the tooth, which is an important consideration. The surface of the filling should be made to conform to that of the lost portion of the tooth; this can always be done except where the tooth is largely broken away, and even then very much may be accomplished in many cases to restore the lost form; that will depend, however, upon the method of using the gold, and the security of the attachment for it. In crown fillings of the molars and bicuspids, the antagonism of the teeth must be regarded; they should be formed for the reception of the cusps of the opposing tooth. Proxi-

mal fillings should usually be convex; yet many good fillings of this class are made with a surface perfectly plain with the borders of the cavity. The borders of the filling, however, are better protected when it is somewhat convex.

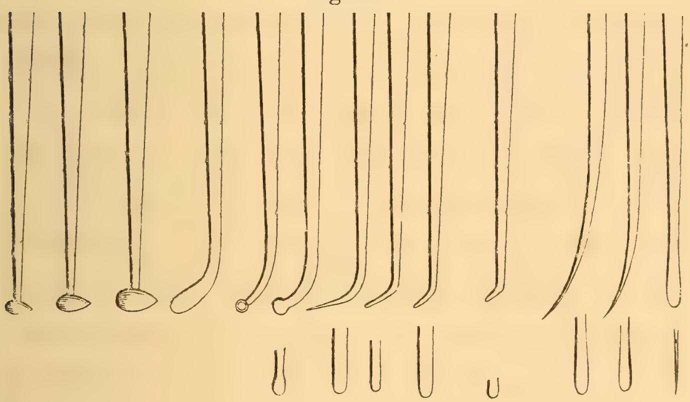
Crystal gold, of perfect character, presents to the walls of the cavity a surface better calculated to be retained than foil in any of its forms; though cohesive foil possesses this advantage to a greater extent than foil in any other condition. The points and edges of the crystals are brought in contact with the walls, and take a firmer hold upon the dentine.

In forming crystal gold into a solid mass, two principles are operative: cohesion acts upon it as potentially as upon gold in any other form, and, in addition, there is the interlacing, or locking, of the crystals with one another; so that a more perfect union of the different portions of which a filling is composed is obtained with crystal gold than with foil. Yet good cohesive foil, when properly manipulated, attains almost the same condition.

It is important to keep the gold perfectly free from moisture while being introduced and consolidated; for moisture instantly destroys its cohesive property. And the more complete the exclusion of moisture from the cavity during the process, the better for the success of the operation. The surface of every

filling should be consolidated for finishing before it is allowed to become moist, for if it becomes saturated with moisture before consolidation, it is impossible to make a perfect finish. There should always be gold enough superadded to insure this; and the consolidation of the surface should be effected with a burnisher of the proper form, used with the mallet, consolidating the entire surface as thoroughly

Fig. 83.



and smoothly as possible, exercising great care about the borders of the filling. Fig. 83 represents the forms of the burnishers suitable for almost all cases.

FINISHING FILLINGS.

The method of finishing a filling, and the manipulation required, will depend somewhat on its locality. When the filling has been thoroughly consolidated

over all the surface, and especially all round its border, the file should be applied to dress off any projecting portion, and render it smooth. In consolidating the surface, an instrument should be used that would not pit it, and the file or finishing bur should remove all indentations. The work of these, however, should be but partially performed at first, and the surface burnished again. To obtain the most perfect finish, the surface should be brought to a uniform consistence; and this condition cannot be reached by the use of sharp-pointed instruments, nor fully by that of the blunt plugger at the first effort, but by the alternate use of the file, the blunt condenser, with the mallet, and the burnisher. A coarse file or bur should be employed in this part of the process; but when the filling is dressed sufficiently, and in good condition, the fine file should be used alternately with the burnisher, till a perfectly uniform surface is obtained. In all cases, after the file has been applied, the plug should be washed off with a brush, to remove all detached pieces of gold, before the burnisher is put upon it; and after the fine file and burnisher, the Scotch or Arkansas-stone, or corundum slips of the proper form, used with the port-polisher, or very fine pumice, should be employed to remove the file-marks. The pumice may be applied with water on a strip of chamois skin, a piece of

linen tape, or a stick of soft wood—the latter being the most convenient, as it can be used with one hand—shaped to suit any place or position. Emery cloth of every requisite grade of fineness is now obtainable; this may be cut into strips of any desired width. It is very efficient for finishing all fillings in the proximate portions of the teeth.

After the stone or the pumice has accomplished its work, and the filling has been thoroughly washed, a fine burnisher, with a solution of castile soap, is employed to give the finish. The burnisher should be of the best cast-steel, and of high temper and fine polish. Considerable skill is requisite to give the best effect with the burnisher; it should pass smoothly and gently over the surface, throughout its whole extent, and in parallel lines, with a pressure neither too light nor too heavy. It should also be applied very thoroughly upon any portion of the tooth about the border of the filling that may have been cut by the file or any other instrument. Indeed, quite as much, if not more, care should be exercised upon this as upon the plug itself: it should be polished as smooth as the enamel, if possible, for the more nearly perfect it is in this respect, the better will it resist the action of the deleterious agents.

This method of finishing gives to the filling a perfect metallic lustre, which, under some circumstances,

is objectionable. Two other methods are in use: After the burnisher has been applied, as above, the buff or tape, with rouge, may be employed, by passing it rapidly over the filling, till the metallic lustre is destroyed, or deadened, so as not to reflect the light as before, thus leaving a very desirable finish; and the other method is, to stipple over the surface of the burnished filling with the end of a piece of hard wood,—sandal wood is recommended,—charged with finely-pulverized pumice. This gives a beautiful, velvet-like surface, and is applicable to fillings in the anterior portion of the mouth, where they are exposed to view. Rotten-stone, applied either with the buff or with hard wood, imparts a finish which, although a little different, is equal to any of the others.

For finishing, some operators prefer to cut and polish, instead of filing and burnishing. But neither so good nor so fine a finish can be effected in this way, and it is probable that economy of time and labor, especially the latter, suggested the method. The introduction and use of the corundum cones and disks, cones of Hindustan and Scotch stone, and the wood cones and buffs (represented on pp. 115, 116), all to be used with the dental engine, greatly facilitate the work of finishing, and perhaps accomplish it better; but great care should always be exercised in

the use of these implements. In all cases the filling should have a distinct and definite margin; the gold should be trimmed off quite up to the border of the cavity, by passing round it a small sharp instrument, so as to detect and pare down any portion that might overlap the tooth; for if overlapping portions are permitted to remain, foreign substances will lodge beneath, and induce decay. Neglect in this particular has occasioned the loss of thousands of teeth that otherwise might have been saved. This direction does not apply to those cases elsewhere mentioned, in which it is recommended to form a thick, firm, overlapping portion, for the protection of a thin friable border.

The subject of finishing is almost entirely overlooked by very many operators, but by the neat and skillful it is esteemed of sufficient importance to demand as great labor and pains as any other part of the work.

CHAPTER VII.

CLASSIFICATION OF DECAYED CAVITIES.

The following classification of decayed cavities in the teeth, though from the very nature of the subject imperfect, will be found sufficiently accurate to aid the dental student and the practitioner. It is based primarily on the position of the cavities, and secondarily on the extent of the decay,—the *classes* having reference to the former and the *modifications* to the latter. The *classes* are numbered according to the accessibility of the cavities, beginning with those most easily approached and operated upon, and the *modifications* according to the extent of the decay, beginning with the smallest and simplest in form.

First Class.—Simple central crown cavities in the molars and bicuspids.

1*st Mod.*—Extension of the decay along one or more fissures or depressions.

2*d Mod.*—Two decays in close proximity on the same crown, which may be formed into one cavity for filling.

Second Class.—Cavities in the buccal and palatal

surfaces of the molars and bicuspids, and in the labial and palatal surfaces of the canines and incisors.

1*st Mod.*—Extension of the decay beneath the margin of the gums.

2*d Mod.*—Extension of the decay so as to involve a portion of the crown surface.

THIRD CLASS.—Anterior proximal cavities of the bicuspids and molars.

1*st Mod.*—Extension of the decay toward the neck of the tooth, beyond the termination of the enamel.

2*d Mod.*—Extension of the decay so as to involve a portion of the grinding or crown surface.

FOURTH CLASS.—Proximal cavities of the incisors and canines.

1*st Mod.*—Palatal wall of the cavity broken away.

2*d Mod.*—Labial wall broken away.

3*d Mod.*—The cavity at the point of the tooth, terminating at the surface.

4*th Mod.*—The borders of the cavity very thin, and the lateral walls inclining to the centre.

FIFTH CLASS.—Posterior proximal cavities of the molars and bicuspids.

Modifications same as those of third class.

Modifications common to all the classes:—1*st*. Superficial cavity and a large orifice. 2*d*. Deep cavity and a small orifice.

Modification common to classes three, four, and

five:—Transverse extension of the decay round one or more angles of the tooth, under the termination of the enamel.

FILLING BY CLASSES AND MODIFICATIONS.

First Class.—Central cavities of the molars and bicuspids. These decays always begin in the depressions on the masticatory surfaces, which are vulnerable points, the enamel-membrane folding together here, and often being imperfectly united, so that an opening is left partially or wholy through it to the dentine; besides, these indentations afford lodgment to foreign substances, which may be forced into them in the process of mastication, and there retained till, becoming vitiated, they produce decay.

Examine carefully the extent and the nature of the decay, and the form of the cavity, which, of course, greatly varies. In some cases the cavity is found with a small diameter and a comparatively great depth, the diameter at the orifice being the same as within; in others, with a diameter larger at the orifice, as occurs in cases in which a considerable portion of the enamel at the depressions on the crown is imperfect. In the majority of instances, however, the diameter of the cavity is much larger within than at the orifice. Sometimes the decay is

found to burrow directly beneath the enamel more rapidly than in any other direction, as where there is an imperfect union between the enamel and the dentine. In other instances, the cavity seems to expand uniformly as it extends into the tooth.

The manner of opening up and preparing the cavity for filling will depend somewhat on the form given to it by the decay. If it is larger at the orifice than within, there will be little or no cutting of the cavity about the orifice necessary, except to make it even and smooth; and its preparation will consist in an entire removal of the decay, and such shaping of the interior as will insure retention of the filling. This may be effected either by enlarging the cavity within, till its walls are parallel with each other, or, if these are left converging, by forming pits or grooves upon them at proper points. Converging walls present one or two advantages, which will be hereafter considered. Usually, where the decay has formed a cavity of nearly uniform diameter from the orifice to the bottom, about all the preparation for filling that is requisite is a thorough removal of the decay. In cases in which the decay burrows under the enamel, the projecting portions are to be cut down, either with a bur drill or, what is generally better, a heavy cutting instrument. In most instances it is best to cut away the enamel as far as the decay has extended

beneath it, since it is difficult to make a perfect filling under a projecting portion. In some cases, however, where the enamel is thick and firm, it is admissible to leave a slight projection, so as to form a shallow groove.

The walls of these cavities will be of various inclinations. If they converge, pits or grooves may be required upon them for retaining-points, especially if the enamel is cut away at the orifice to the solid dentine. If, however, the walls, or two opposite walls, are parallel, or but slightly divergent, these special retaining-points will not be requisite, except for the reception of the first pieces of gold. Small cavities of this class may be opened up and formed principally with the bur and drill; and even in large cavities much of the work of opening, excavating, and forming may be done with burs of the proper size and form, used with the engine. Thus the orifices of the small cavities would be round, while those of the large would be of various forms, determined by the direction of the decay, as, round, square, triangular, elliptical, parallelogramic. Cavities should not be formed much larger within than at their orifices, unless the filling can be consolidated so perfectly that it will not yield in the least under the greatest pressure of mastication; for, if there is yielding in such cases under direct pressure, the fill-

ing being forced into a larger part of the cavity, withdraws from the walls, leaving an interval corresponding with the depression it has undergone; and thus fluids would be admitted between the walls and the filling, and the purpose for which this was inserted would be entirely defeated.

Many operators ream the orifices of all the small and medium-sized cavities of this class, in order thereby to make a better finish to the border of the filling. Some operators prefer in all cases to remove the angle formed by the wall of the cavity and the surface of the tooth about the orifice, giving a rounded form to the border of the orifice, the object being to avoid fracturing or comminuting the edge of the enamel or dentine about the cavity. All acute angles in these cavities, especially if they extend to the orifice, should be obliterated, since it is impossible to fill them perfectly. This obliteration can be effected with a miniature chisel, or with the appropriate excavator, or, perhaps better still, with the bur of the proper size and shape.

After the formation of the cavity, the next particular is so to arrange as entirely to exclude moisture, whether from the saliva or from the breath. If provision was not made at the beginning of the operation for the exclusion of moisture, it cannot now be longer delayed. As already intimated elsewhere, this

is accomplished by the use of the rubber dam. The general method of its application has been considered, yet a few suggestions in reference to it in an operation upon this class of cavities may be of value, especially to the beginner.

The precise method of procedure at this point will be modified by the size of the mouth, and the ability or will of the patient to control it. For a cavity of this class, it will, in nearly all cases, where the mouth is favorable in the particulars just referred to, be quite sufficient to embrace with the rubber only the tooth to be operated upon, and this whether it be in the superior or inferior jaw.

If the tooth in question stands in firm contact with its neighbors, passing the rubber between the teeth may be quite unnecessary, but let it be drawn over the crown, and down or up, as the case may be, upon the buccal and lingual sides to the margin of the gum, then place on the clamp, which will hold all in position.

This properly done, all moisture will be effectually excluded; success in this, however, depends somewhat on the accurate adaptation of the clamp to the tooth. If the rubber can be readily passed between this and either or both of the contiguous teeth, it is well to do so, thus making the work more secure, if the clamp should be defective in adaptation. When the mouth is small, or not properly controlled,

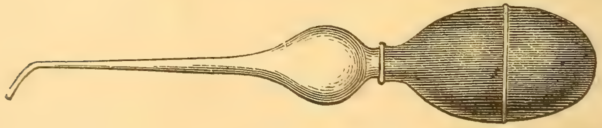
greater precaution will be requisite; in such cases the rubber should always be passed between the teeth, and in some instances over one or two neighboring teeth, in order that the operation may not be embarrassed by encroachment of the rubber. But in no case should it be placed upon more teeth than is necessary to meet the demands of the case. The free border of the rubber should now have the bands and weights applied, so that the utmost freedom of approach may be made to the point of operation. The cavity should be thoroughly dried with bibulous paper and the warm air blow-pipe, when a minute examination of the cavity, at every point and in every particular, should be made, and any imperfections remedied. And now, with the automatic saliva extractor in place and operating, the work of introducing the filling may proceed.

In some small simple cavities of this class, in the upper teeth, with conditions favorable, and but a short time required for introducing the filling, the following arrangement may serve the purpose: Wipe dry the mucous membrane about the mouth of the duct of Steno; lay directly upon this a piece of heavy blotting paper, or a roll of bibulous paper; then take a napkin folded cornerwise, place the end of it upon the paper, between the cheek and the gum, passing it back of the tooth to be operated upon, along the palatal surfaces

of the teeth and the gums to the anterior part of the mouth, and letting a fold of it extend down from this, and out over the inferior front teeth and the lip, so as to protect the tooth from the breath, and catch any fragments of gold that may drop from the instrument. The napkin and paper, thus arranged, are to be kept in their place by the fingers of the left hand of the operator; and if the mouth of the duct is kept closed by the paper, a complete exclusion of moisture is secured, so far as that source is concerned. In some cases pressure of the fingers on the napkin over the duct is necessary; in others, the paper adheres to the mucous membrane, and effectually prevents the egress of saliva. The cavity should now be dried by the method heretofore described, and it is ready for the filling.

In the absence of the automatic saliva extractor, the saliva pump represented in Figure 84 will serve

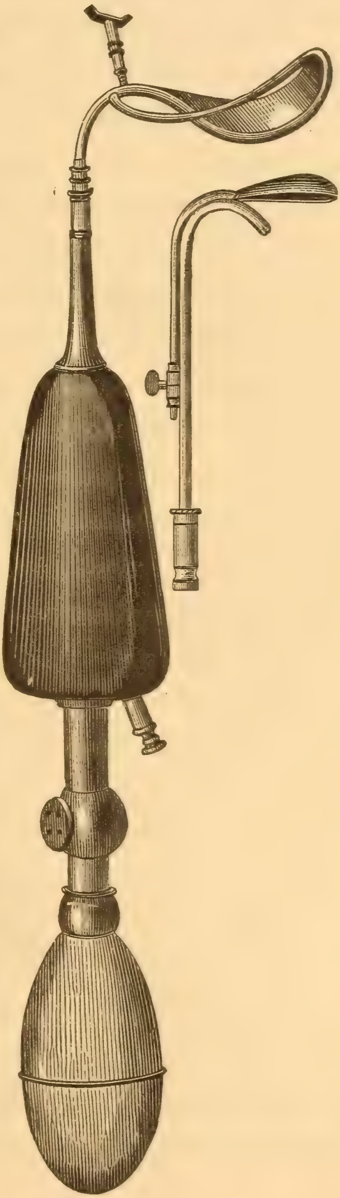
Fig. 84.



a valuable purpose, though it does not completely fulfill the requirements.

An instrument invented by Dr. W. H. Dibble, called "Dibble's Saliva Pump," performs the work of

Fig. 85.



both the saliva pump and tongue holder. As a saliva pump it is much superior to the instrument represented in Fig. 84, which is in common use.

It is operated by the patient, and removes the saliva immediately after it enters the mouth, and may be in constant action, without the slightest interruption of the operation of filling; the saliva passes into a reservoir, and is perfectly enclosed till the operation, however protracted, is completed.

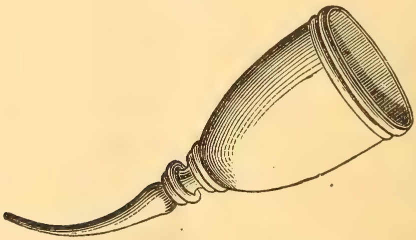
That part of the instrument designed to hold the tongue and the buccal surface from the tooth to be operated upon, and to hold the jaws apart, is of a very excellent form, and accomplishes its work well. It is in three parts, one

adapted to each side of the mouth—in these the saliva is taken up by the instrument opposite the lingual surface of the second inferior molar—and one for the front, with a compressor passing on to the tongue and holding it firmly down, and the pump-tube takes the saliva from the immediate vicinity of the sublingual ducts.

This latter part of the instrument is the device of Dr. B. F. Arrington. The instrument is well represented in Fig. 85. That part of this instrument designed to hold down the tongue is rendered unnecessary by the use of the rubber dam.

It is often the case that the finger is too short to reach a desired point, to hold down a napkin or paper, or hold away the soft parts, or is so large as to fill the space inconveniently, obstructing the view of the operation. To overcome both of these difficul-

Fig. 86.

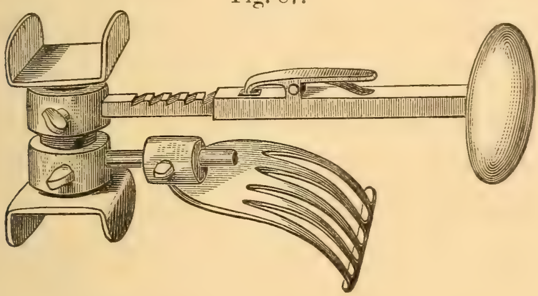


ties, an extension thimble is used; it may be made of silver or rubber, though better of the former. In addition to the uses mentioned, it may, by having a

fine steel point, be made to serve as a holder to aid in introducing fillings. (Fig. 86.)

Various appliances have been used for holding away the cheek, keeping down the tongue, and re-

Fig. 87.



taining the jaws apart. An instrument for this purpose is shown in Fig. 87.

Filling with Foil.—If non-cohesive gold is employed, it should be formed into blocks, by cutting from four to eight thicknesses into strips one fourth wider than the cavity is deep, and rolling them on a broach suitable for the purpose, into cylindrical blocks corresponding in size with the cavity to be filled, and varying not only in size, but in form and density. The blocks first to be introduced should be largest, followed by those diminishing in size, the last portions being small, dense, conical rolls. Where there is an inward or outward inclination of the walls of the cavity, the first blocks should be cone-shaped. For introducing the blocks, the plugging pliers will

be required. The first block is taken up with this instrument and placed against the posterior wall of the cavity, with one end on the bottom and the other protruding from the orifice, and there compressed firmly to its place with the appropriate condensing instrument; and, unless there is some special retaining point, it may be necessary to hold it in its position with a second instrument, till the next portion is added. As the successive blocks are introduced, each is to be thoroughly consolidated, so as to be immovable. The filling is to proceed from the posterior wall to the centre. After the cavity has thus been filled to the centre, commence in the same manner at the anterior wall, filling from thence toward the centre, and condensing the last blocks by forcing in at their side a small sharp-pointed instrument; the final portion introduced will be the small, dense, conical roll already mentioned. The gold being all introduced, a smooth-pointed instrument or burnisher condenses the projecting portion of the filling till it is perfectly solid, when it is finished with a file, stone and burnisher in the manner already described. The particular shape of the surface of the filling will be suggested by the form of the antagonizing tooth. Usually the surface of these fillings should be slightly concave; in some cases the occlusion of the teeth is such as to require very

considerable concavity; this, however, should only be sufficient to accommodate the closure of the teeth.

For dressing down the burs, corundum cones, Scotch stone and buff cones used with the engine, represented by Figs. 28 and 29, will serve the purpose most fully.

Cohesive Foil.—For filling these cavities with cohesive foil, definite retaining-points should be formed in them, or the bottom of the cavity of such a form as to retain firmly in position the first pieces of gold introduced. The gold, prepared in the manner already described, is taken up with a serrate-pointed plugger or plugging pliers, introduced into the retaining point or points, and there fixed; it is then built across from one to the other, and over the floor of the cavity till this is completely covered, and then up from the bottom to the orifice. When a portion of gold is taken on the point of the instrument, the precise spot at which to deposit it should be selected, and there it should be placed, and, by the first pressure of the instrument, fixed immovably; a few subsequent strokes of the instrument, near the first point of attachment, will be required. These strokes should be close, because if the instrument is lifted up and pressed upon the piece at a distance from the first point of contact, the attachment is liable to be broken. The character of the gold, and

the condition of the receiving surface will govern to some extent the precise method of manipulation. Very much depends upon keeping the surface in a good condition for the reception of the gold to be added. The best receiving surface is obtained by having the condensing instrument sharp and in good condition, and then in using it, let there be a little space between its impressions—the surface not stamped completely over by the condensing instrument. In constructing the filling, we consider it preferable to keep it built up a little higher all around next the walls than at the centre, for the reason that a more complete adaptation of the gold can thus be made than by any other plan. Some, however, advocate the opposite practice; that is, of keeping the filling higher in the centre than at the walls, and thus forming an angular space into which to crowd the gold; because the gold is thus kept in more thorough contact with the walls of the cavity; and it is objected that, to add and consolidate the gold to the centre, while the edges are left higher, tends to draw them from the walls. This objection, however, has no force, if the gold is thoroughly consolidated as it is introduced.

The cavity is thus filled up, consolidated, and finished in the usual manner. In adding the last portions of gold, great care should be taken to make

a perfect border to the filling. Crystal gold may be very advantageously used as a foundation for cohesive foil fillings, as it will retain its position perfectly in a cavity, where foil will not.

Crystal Gold.—The method of filling this class of cavities with crystal gold is very simple. The material should be annealed just before its use, and then cut or broken into blocks corresponding with the size of the cavity to be filled; they may be used as large as will freely enter the cavity; many small pieces will be required to fill up interstices or angles. The filling may be commenced at the bottom of the cavity, and built up from that to the orifice, the same plan being followed in adapting it to the walls as with cohesive foil, the pieces being passed into the cavity with either the plugging pliers or a condensing instrument. Each piece should be well consolidated before another is added. For condensing the filling next to the walls, a small wedge-shaped instrument is valuable. In all cases where there is a divergence of the anterior wall, much care is required in order to make a perfect filling; and too much care cannot be exercised in perfecting the filling round the border of the cavity. In condensing cohesive foil or crystal gold, the force may be applied almost exclusively in a line with the axis of the tooth; and this is always preferable to lateral pressure.

1*st Mod.*—Extension of decay along one or more of the crown fissures. In a case of this kind, the central cavity is first to be opened and excavated, according to the principles already announced. Decay in the fissures is in some cases an extension of this central decay, and at the point of its termination there will be found an acute angle; but in others, it will be the effect of an equal attack all along the fissure, or of an extension from some other point than the central cavity. This modification of decay may terminate either in an acute angle or in an expansion.

These decayed fissures should be opened up by cutting away any projecting portion of enamel, and the cavities formed with a small chisel-shaped instrument, beginning at the juncture of the fissure with the main cavity, and cutting down to the bottom of the decay in the manner of a mortise, thus cutting out the entire fissure and the acute angle at its termination—the latter an important consideration. In case there is a very considerable expansion of decay at the termination of the fissure, the bur drill may be introduced into it, and the rest of the fissure cut out, as the form of the cavity may indicate. In excavating and forming these fissures, the burs made for the purpose (shown in Fig. 22), and used with the engine, give greater facility and rapidity of execution

than by the method just described, and with care, equally as definite results.

If blocks are used to fill these cavities, they should be set in and compressed against the end of the fissure, protruding from it sufficiently to admit of a proper finish; and block after block added, till the fissure is filled up to the main cavity. Where there are two or three of these decayed fissures in one tooth, it may be quite as much as can be done at one sitting to fill them, the main cavity being left for another time. In such cases, the filling introduced at the first sitting should then be consolidated and burnished, so that it may not absorb moisture while the main cavity is filled, as already described. Much care should be exercised to prevent the gold from overlapping the enamel at the sides of these fissures. In filling this modification with crystal gold or annealed foil, it is better to begin at the bottom of the cavity and build up to the orifice, first completing the fissure, as we have already described, and afterward the main cavity.

2*d Mod.*—Two cavities on the same crown in close proximity. The thickness of the portion of tooth intervening between two cavities on the grinding surface of the same crown is determined by the location and extent of the decay and by the form of the cavities; and these two conditions will suggest the

method of operation. If this intervening portion is thin throughout, and devoid of vitality, it should be cut away, and the two cavities formed into one; but if it is thick within, though it may be thin at the surface, the cavities should be filled separately. In some cases it is proper to leave a part of it standing, as a sort of ridge between the cavities, though not as a definite partition; in which case the filling would be commenced as in two cavities, and finished as in one. In no case, however, when the tooth is living, should this intervening portion remain, if its vitality is gone. The details of the process of filling crown cavities have already been indicated.

Second Class.—Buccal and palatal cavities of the molars and bicuspids, and labial and palatal cavities of the canines and incisors. In the molars, this class of decay begins either at the margin of the gum, in the form of a transverse groove, or along the vertical depression on the buccal surface of the tooth, or at its termination. These groove-like decays, extending along the side of the tooth at or near the margin of the gum, are ordinarily not very deep; but they burrow considerably under the enamel, particularly at the side next the grinding surface. In preparing these cavities, the projecting portion of the enamel must be mostly cut away, leaving them but slightly larger within than at the orifice. These grooves, at

their ends, are shallow; but in their preparation for filling, they should be cut as deep at the ends as elsewhere, and when the main part of the cavity is comparatively shallow, deeper. Much difficulty is often experienced in protecting these cavities from moisture while being filled. The rubber dam, when well applied, accomplishes the object better than any other appliance; it is in such cases invaluable.

The method of introducing gold in the form of blocks into these cavities, is to set in the first block at the posterior part of the cavity, and consolidate it, and so one block after another till the cavity is nearly full; and then proceed in like manner with the anterior end, back toward the middle, the blocks, of course, being permitted to protrude sufficiently for the purposes of a finish. For filling with crystal gold or cohesive foil, the method is, to form pits at the end of the groove, into which the gold is consolidated, and built across from one to the other, and then up from the bottom to the orifice, when it is finished as usual. Care is requisite to prevent the gold from overlapping the tooth outside of the cavity. Any projection of the filling, especially beyond the margin of the cervical wall of the cavity, is very objectionable; it would afford a lodgment for extraneous substances, the tendency of which is to produce irritation and decay.

Cavities of this class, which are formed in the depressions of the buccal portions of the teeth, are more easily filled. Often a simple round cavity is formed at the coronal termination of this depression, which may be entirely prepared with a bur drill. The method of filling these cavities will be readily inferred from the remarks before made. If, however, the decay extends along the depressions, making a groove-like cavity, this should be filled by commencing the introduction of the gold at that part of the cavity next the gum.

1*st Mod.*—Decay at or near the neck of the tooth, and partially or wholly overlapped by the free border of the gum. In this modification the gum is a great obstacle to the various steps in the process of filling. It is liable to be wounded and to bleed at every touch; it exudes mucus constantly; and it conducts saliva to the part with great facility. To obviate these difficulties, the gum must be removed somewhat from the cavity before the filling is practicable. This removal of the free margin of the gum may be made either by cutting away, or by pressing away with pledgets of cotton or other appropriate substance placed in the cavity and projecting from it, so as to make pressure upon and absorption of, to a sufficient extent, the free margin of the gum, which will usually be accomplished in a day or two. The for-

mer method, however, accomplishes the object at once: some good hemostatic, as creasote and tannin, is all that is then necessary to render the filling immediately practicable. By means of this application the exudation is checked,—which, where there is much mucus eliminated, is an important item,—and also such a surface is given to the part that it will not so readily conduct the saliva. It is perhaps preferable in many cases to cut away this free margin, so that it shall not be in contact with the filling after the operation is completed. In nearly all such cases, by the proper application of the rubber dam with a perfectly-adapted clamp, the whole difficulty will be overcome.

After this preparation, the cavity is formed and filled as usual.

In filling cavities of the buccal portions of the *dentes sapientiæ*, peculiar difficulties are met with. The decay is frequently found two-thirds covered by the gum; the muscles of the cheek, thick and rigid, lie close against the side of the tooth; and, in most cases of this kind, the view, at best, is but partial. To meet this difficulty, a clamp with a broad flange upon its outer blade is required for holding the soft parts away, and the rubber dam in its proper position.

In nearly all such cases the reflector should be

used to concentrate light upon the locality of the operation; without this, the view into these cavities is much obscured.

THIRD CLASS.—Anterior proximal cavities of the molars and bicuspids. This class of cavities in teeth with short, broad crowns, takes place at their necks; but in those with long crowns, and with a diameter less at the neck than at the masticating surface, it begins at some distance from the neck, toward the crown surface, or at the first point of contact of the crowns. In almost all cases of proximal fillings separation of the teeth is required; the method and extent of this will be determined by circumstances. If all the neighboring teeth stand in contact, it cannot be easily accomplished by pressure; in this respect, however, there will be found a great variety; but if a tooth has been extracted in the vicinity, or there are natural spaces between the others, it can be either in whole or in part. When, however, the teeth stand close together, they must in such case be separated chiefly with the chisel and file. If but one is decayed, the cutting should be exclusively from that. If two are alike affected on their proximal surfaces, it should be mostly from the posterior surface of the anterior tooth. In regard to the form of the separation effected by cutting, the general practice formerly was to cut down the whole proximal

side of the affected tooth, making between it and the adjoining one a V-shaped space, sufficient in extent to admit of free manipulation in all parts of the operation of filling. By thus cutting the teeth, the form is marred, and often to great disadvantage in use, as by it the masticating surface is lessened, and food being crowded into such a space, produces very unpleasant pressure. In order to preserve the form and the greatest amount of masticating surface to the tooth, a preferable method is to cut down from the masticating surface to the cavity of decay, leaving the lingual and buccal sides of the tooth untouched, except, perhaps, a little dressing that may be rendered necessary by the thinness and roughness of the margins. This cutting should extend about as far toward the centre of the tooth as the decay has penetrated, and be nearly as wide as the extent of the decay across the tooth; it should be of dove-tail form, or that part of the opening next to the centre of the crown slightly wider than at the anterior part. This form may very readily be given by the properly-formed excavators, or more rapidly, and quite as well, with the fissure burs and engine. Care should be exercised in this particular lest the lateral walls of the cavity be weakened by this cutting; and in doubtful cases, rather than incur such risk, it is better to avoid making the expansion altogether, and

rely upon other modes of anchorage for the filling. The attachment of the filling may be made by properly-located pits and grooves. In making these, two points should be guarded, viz.: weakening the walls of the cavity, and impingement upon the pulp. Care, good judgment and experience are necessary to most fully meet these requirements. When it is necessary to cut from the whole proximal surface, there should be no shoulder or projection left at the neck of the tooth, but the cut surface should be plain from the crown to its termination at or near the neck. The space, of whatever form it may be, should be large enough to enable the operator to manipulate with facility, and to see as directly as possible into the cavity.

Cavities of this class are various in form; and they require much skill in their excavation and formation. Great care is to be exercised not to leave any portion of decay in them. By a fatal oversight, decayed dentine is often permitted to remain on that side next to the neck of the tooth; and fillings that in other respects are good, are very deficient here—so deficient, indeed, that a sharp instrument will readily penetrate the softened dentine above them, or even pass between the filling and the wall of the cavity. The removal of the decay from the cervical walls of all proximal cavities is an important particular, neg-

lect of which occasions thousands of failures. This class of cavities at this point should be most thoroughly filled; for it is a point more vulnerable than any other, on account of the facility with which foreign substances are here lodged and retained.

In the formation of these cavities, the cervical wall should be made to incline slightly outward, and the lateral walls, if the tooth will bear the loss, made at least parallel with each other; but if that would impair its strength, grooves or pits may be made upon them for this purpose at proper points. When these cavities are large, the dentine is usually all decayed in that part of the cavity next to the masticating surface of the tooth, leaving only the enamel, which by the mode of separating or opening, already described, would be cut away.

The rubber dam being properly adjusted, the cavity is ready for the filling, which is introduced, if in blocks, as before detailed, beginning with the cervical wall. The caution may here again be urged, not to let the gold overlap the tooth, particularly at the cervical wall. In filling with crystal gold or cohesive foil, special retaining points will be required in this wall, two being generally sufficient, one toward the outer and the other toward the inner lateral wall, on both of which grooves may be made, if the walls are thick enough to admit of it. If, however, these

walls are not parallel, and will not admit of grooves, the crown and the cervical walls should be so shaped as to retain the filling. But in some cases the attachment of the filling is made entirely at the cervical wall; and best by means of three pits, made with the square-pointed drill at different angles, and in such directions as not to interfere with the pulp. This kind of attachment will serve only for cohesive gold, which is to be very thoroughly consolidated into the pits, making little projections, which are so many anchors for fastening the filling, and built very firmly across from one to the other.

2*d Mod.*—Decay involving a portion of the masticating surface. There are two methods of filling this modification. One is, to cut down the tooth or the projecting angles, and make a plain, oblique border to the cavity by the V-shaped separation already referred to, and then fill up flush with this border. The filling will thus exhibit a single, uniform surface, at a considerable angle with the axis of the tooth. When a portion of the crown breaks down in consequence of proximal decay, it is toward the centre of the tooth; usually the inner and outer corners remain. If these projections are feeble and liable to be broken away, they should be cut down and the cavity filled as before described. If, however, they are firm, they should remain, and the cavity, pro-

perly formed, may be filled so as to restore the tooth's original form, which in the molars and bicuspids should be accomplished as nearly as possible, in order that the function of mastication should be perfectly preserved. By properly-directed effort, the crowns of the teeth can in almost all cases, even where the walls are broken away, be well restored. Non-cohesive foil is not adaptable to this kind of filling, as it cannot be built in so as to withstand the pressure of mastication. In no case should a proximal filling be left in contact with the adjoining tooth.

Fourth Class.—Proximal cavities of the incisors and cuspidati. If the teeth are not in a crowded condition, and the file is not required by the extent of the decay, separation may be made by pressure; but if the cavity is large, and the walls are thin and friable, cut with a thin chisel and file only till a good border is obtained about the cavity. Much has been said as to the form of these separations, some recommending that they be larger at the palatine part than at the labial; others, that they be larger at the points than at the necks of the teeth; some, that a shoulder be left at the necks; and others, that there be no shoulder at all. In making these separations, however, the operator must be governed somewhat by circumstances, no general rule being applicable to all cases. The form of the teeth and the extent of

the decay, together with the character of the remaining enamel and dentine, will modify the form of the space between them. If the inner wall is thin or broken away,—and it is usually more friable and more broken than the labial wall,—it should be cut off more than the outer; in which case the palatine aspect of the separation will be the largest—as, indeed, some prefer to make it in all cases, performing the remainder of the operation from the inside. Almost every operation upon these teeth will require attention and manipulation, in every step, from both the palatine and labial sides, in order to make secure every point. The precise mode of procedure must be determined by the case to which it is to be applied. The most direct approach is always to be employed when practicable.

In some cases separation will be larger at the points of the teeth than elsewhere; as, where there has been a partial fracture at the points. In cutting away to make the separation, no shoulder should be left at the neck of the tooth that is not to be protected by filling; any projection of that kind is always objectionable: foreign substances lodge upon and adhere to it, and, becoming vitiated, render it very liable to decay. The cutting should always extend entirely beyond the decay, but only far enough to make a perfectly plain border to all the cavity,

and should terminate without any projection It is highly important, in separating the anterior teeth, to make as little alteration as possible in their form. But the preservation of the tooth should not be jeopardized for the sake of maintaining the integrity of its natural form. The first consideration should be to obtain a space sufficient for the purposes of a perfect operation; the second, to have the walls and border of the cavity in such a condition that an efficient filling can be made; and the form and beauty of the tooth should be scrupulously preserved and protected, so far as the above requirements will permit.

The excavation of these cavities requires very delicate and skillful manipulation, since they are very readily injured by cutting too much or at a wrong point. All decayed and discolored portions must be entirely removed, as well for the appearance of the tooth as for the permanency of the operation; after which the cavity is to be formed with great care. Toward the cutting edge of the tooth the dentine often has all been displaced by decay, leaving only the two plates of enamel joined at the edge, and thus forming an acute angle, the obliteration of which is always attended with risk, unless great care is exercised, and in many teeth it is wholly impracticable; and still it is difficult perfectly to fill such

an acute angle. The inclination of the inner and the outer walls of the cavity will depend on its size; when it is small or medium, they may be parallel, or, if necessary, slightly divergent inward; but when large, it is better not to cut much of the healthy dentine from them, lest they be thus weakened. Small grooves, however, are admissible on these walls, near the bottom of the cavity, when they incline to the centre, and are generally, in such case, to be preferred to pits. In the formation of grooves or pits for anchorages, the dentine should never be cut through to the enamel; but always dentine sufficient to protect the enamel should remain. More cutting is allowable on the cervical wall than elsewhere, as there is less danger here of weakening the tooth by excavation. In some instances the cavity, upon the removal of the decay, is of such extent and form as to admit of little or no excavation, except in the cervical wall; in this, then, the chief anchorage is to be made, and almost the entire reliance for the retention of the filling must be placed upon that part. Such a condition renders the use of cohesive gold a necessity, at least if a permanent result is to be attained. The best method of preparing such a cavity is to make two or three little pits in it at different angles with a fine, square-pointed drill. Another method is, to form two pits, and make a

groove from one to the other. Some operators prepare these cavities by making pits in each of the walls. This, however, is unnecessary, if the cervical wall is properly prepared.

In the application of the rubber dam for filling this class of cavities, three, four, or more teeth should generally be included, in order that there shall be absolute security against moisture, and that the rubber shall be out of the way of the operation. The gold, prepared as already described, should then be introduced with a small plugger, serrated and somewhat flattened about a line above the point, so as to be freely used when introduced into the cavity. The gold is taken up on the point of this plugger, and condensed in the pits of the cervical wall: which, being completely filled, and the gold extending from one to the other, the foundation is ready for the remainder of the filling.

Great care is requisite in packing the gold into these cavities, perfectly to adapt and adjust it to all points, so as to insure its thorough contact with every part of the interior. If the form of the tooth has been measurably retained, and the border of the cavity is even, the surface of the plug should, when finished, be slightly convex, or as nearly the original form of the tooth as practicable. In introducing the filling, reference should be had to this particular.

Two-thirds of the cavity may be filled by introducing the gold upon and in the direction of this cervical wall, and the remaining portion filled from the point back to the preceding filling; or, what is probably better, begin at the bottom and fill to the surface, and then finish in the usual manner.

For filling these cavities with non-cohesive foil, the special retaining points already described are not required; but the cervical wall of the cavity is slightly cut under, and the lateral walls so shaped as to secure the filling in place. These cavities are in some cases very difficult to fill with non-cohesive foil, whether in the form of blocks or otherwise, especially where they are large, with the walls inclined to the centre, and the tooth bone friable. To force a wedge-shaped instrument into these fillings, for the purpose of condensing them, is not admissible, since there is thus great danger of breaking the walls of the cavity, and in many cases of moving the filling from its place.

1*st Mod.*—The palatal walls broken away. Fractures of this kind assume different forms; sometimes triangular, extending from the border of the cavity toward the centre of the tooth, and terminating in an acute angle; and sometimes the border of the cavity is broken away irregularly, or so as to form part of a circle. When a triangular notch is broken out of the

wall, the operation of filling may be performed in one of two ways: If the portions of the wall remaining at each side of the fracture are thick and firm, they may be left, and the cavity filled, so as to restore the form of both the proximal and the palatal surface of the tooth, the latter being thus restored with gold to the extent of the fracture or notch. If, however, the remaining portions of the wall are frail, they should be cut away till a border is reached sufficiently firm to sustain the filling. Such cutting will leave the notch of a circular form, and in many cases will remove almost the whole of the inner wall of the cavity. As the decay extends toward the centre of the tooth, owing to the concavity of its palatal surface, this wall becomes very thin and easily broken, this rendering it necessary to cut it almost all away; but in all cases the excavation should be such as to leave a definite wall, though it be but slight, all along that part of the cavity. In such a case, good retaining points must be made in the cervical wall, since the permanency of the filling will depend almost entirely upon these.

The surface of the filling, when finished, may be slightly convex from one lateral wall to the other; the palatal portion of the surface, from the point of the tooth to its neck, will partake of the curvature of the border of the palatal wall; but the anterior por-

tion will be flush with and assume the outline of the anterior border of the wall. Much care is requisite to give these filings a perfect finish, on account of the irregularity of surface, this in many instances being both convex and concave. As a material for filling these cavities, cohesive gold is much to be preferred. Indeed, in many of them it is impossible, with non-cohesive gold, to make a perfect filling, because they have no general embracing form. In such cases, the filling should be introduced from the palatal side of the tooth.

2d Mod.—The labial wall of the cavity broken. The fractures of this wall are of various forms, and in extent corresponding with the amount of decay and the friability of the enamel. There is sometimes the triangular notch, extending far toward the middle of the tooth; and sometimes there are two or three small notches; and still in other cases, almost the whole of the wall will be broken away from the point to the neck of the tooth. When there is simply a notch in the enamel, it is important for the appearance of the tooth to fill it up; and when there is any prospect of success, the remaining portion of the wall being retained, the operation is to be performed as already described for the palatal wall. It will, however, in many cases, be necessary to cut away part of the remaining portions of the wall, leaving the

general form of the border somewhat circular, though the notch form, in some instances, is not wholly obliterated.

In filling this kind of cavity, it is desirable to restore as much as possible the form of the tooth. The filling should be built out from the border of the wall almost to a line with the tooth's original proportions, so that the whole surface of the filling will be convex; and it should be finished with great care, the Scotch stone, buff, or stipple finish being preferable for that part exposed to view.

3d Mod.—The cavity extending almost to the point of the tooth, and terminating or running out at the surface. In the preparation of this cavity, that part next the point of the tooth should be cut in enough to form a definite wall there, and to give room for sufficient thickness and strength in that portion of the plug. Many operators attempt to fill this kind of cavity without such precaution, terminating that part of the plug in a thin edge. This method is very objectionable, for the thin edge will become more or less separated from the tooth, and foreign substances will be forced under it, and, becoming vitiated, induce decay. Indeed, a defect of this kind is a sure precursor of the destruction of the filling. The introduction and finish of the filling in this kind of cavity are the same as first described for this class; and the

admonition may be repeated that there be left no thin overlappings of the filling that may become changed in position.

4th Mod.—The cavity large, and the lateral walls thin and friable. In this kind of cavity the dentine is almost entirely removed from the lateral walls, leaving little else than the enamel after the excavation of the decay. These walls will of course admit of no cutting for the purpose of giving them a more desirable form. The cervical wall must be shaped with special reference to a retention of the filling, to consolidate which the requisite pressure must be applied almost exclusively toward this wall. It requires extreme care to condense the gold in cavities of this kind, and adapt it to the lateral walls without fracturing them; various methods have been suggested to prevent such an accident. Pluggers with very fine points are recommended, as consolidating the gold with much less pressure than would be necessary with large-pointed instruments. But it has been maintained that a perfect adaptation of the gold to the inner parts of these walls is not important, provided the adaptation at the border is perfect. It is certain, however, that a filling thus imperfectly adapted is not so good as though the gold were in contact with all points of the cavity; and besides, the liability of fracturing the wall is just as great in

consolidating at the border as within. The walls may be sustained by enveloping the tooth to the borders of the cavity with some material perfectly adaptable to it, and capable of resisting the force applied in the process of consolidation, as gutta-percha or plaster of Paris. If the former is employed, it should be softened by warming, moulded upon the tooth, and then permitted to harden. The hardening may be facilitated by throwing cold water on it from a syringe. It is then to be trimmed even with the border of the cavity, so as to admit the filling. If plaster of Paris is to be used, it should be of the best quality. Yet gutta-percha is to be preferred. But a better protection than either may be made of fusible metal, taking an impression of the tooth, and from that moulding the shield. In these fillings, when the enamel is clear and translucent, the gold will be visible through it. To obviate this difficulty, and give strength to the frail walls after the cavity is formed and thoroughly cleansed, it should be filled with oxy-chloride of zinc. Great care must be exercised in introducing this, to secure its perfect adaptation to every part of the cavity; and after hardening has taken place, excavate as may be requisite, leaving enough to constitute a good lining and support to the thin walls, and obscure the view of the gold.

The natural color of the tooth may be in this way

so well restored and maintained as to elude detection; at the border of the orifice the gold should come in contact with the dentine or enamel. In almost all cases of thin weak borders, the gold should be built on and over them, so as to form a shield or protection against fracture or undue wear. All such overlapping portions should be made so thick and firm as not to be displaced or moved.

The loss of a portion of the cutting edge of the incisors by extensive decay is often met with. In all such cases, when the dentine is of good structure, it is practicable to restore the lost part to a greater or less extent by building up with gold. In order to make successful operations in such cases, several points must be regarded. The dentine and enamel should be of good structure; the cavity toward the neck of the tooth of such a form as to afford the best anchorage; this may consist of pits with grooves running out from them. Teeth with thick short crowns present the best opportunity for such an operation; indeed, upon that class of incisors with long thin crowns, such an operation is not usually practicable, and generally these teeth present such a contrast in color with the gold as to be quite objectionable. In the operation the manipulation must be such as to secure the most thorough welding of the portions of gold of which the filling is composed.

With good attachments, gold well prepared and in good condition, and properly manipulated, the filling may be built up to any desired extent without danger of being either drawn out or broken down. The finish should be such as has already been described for fillings exposed to view.

Fifth Class.—Posterior proximal cavities of the molars and bicuspids. These are separated like anterior proximal cavities, except that, ordinarily, to open them up, more is to be cut from the tooth, on account of the greater difficulty of approaching, inspecting and operating in the cavity. The same general principles are applicable to the opening of this class of cavities as to that of the third class, except that pressure for separating cannot be as frequently employed, since the cavity will not be as well exposed by this as by cutting, nor rendered so easy of approach. Indeed, in operating on these cavities, the use of the mirror is often necessary, it being impossible to obtain a direct view into them after having cut away all that it is admissible to remove. This difficulty is almost wholly obviated by the method of working through the masticating surface of the tooth into the cavity of decay, as already described. The accessibility of these cavities will depend on circumstances, such as the location of the tooth, its inclination, the size of the

mouth, the flexibility of the muscles, and the ability of the patient to open the mouth, and keep it open. Generally, in operating on these cavities for the removal of decay, for the formation and the filling, curved instruments will be required, but their curvature should not be greater than the necessity of the case demands.

The cavity, during its preparation, must be frequently examined. Its general form, and the size, kind, and location of the retaining-points, will be the same as in class third. The lateral walls, if the cavity is not too large, should be made parallel with each other; the undercutting at the crown wall will be less than in anterior proximal cavities; and the cervical wall should have a slightly inward inclination—the reverse of the same wall in anterior proximal cavities. In this latter there should be made, at different angles, pits for retaining-points—three if the tooth is a molar, and two if a bicuspid. For making these pits, the engine right-angle hand-piece will be found applicable and convenient.

Preparatory to introducing the filling, the same appliances should be used to protect the cavity from moisture that have been described elsewhere. Great care should be exercised in introducing and securing the first portions of gold. The size, form and location of the anchorage points should be carefully

noted, and into these the filling should be very perfectly introduced; here the most thorough welding of the gold should be made, so that each piece when adjusted will be immovably fixed. The gold extending from one anchorage to another constitutes the foundation upon which the subsequent part of the filling is to be built. This may proceed uniformly from the cervical part of the cavity to the masticating surface of the crown, if, as is usual, the prepared cavity involves this surface.

When the separation made between the teeth constitutes a V-shaped space, the filling should have a single plain or slightly convex surface, which will be at a greater or less angle with the axis of the tooth according to the greater or less amount cut away in the separation. Much care is requisite in order to make perfect work along the borders of the lateral walls of the cavity; these should be secured as the work progresses, and should in no case be left to receive attention after the body of the filling is introduced.

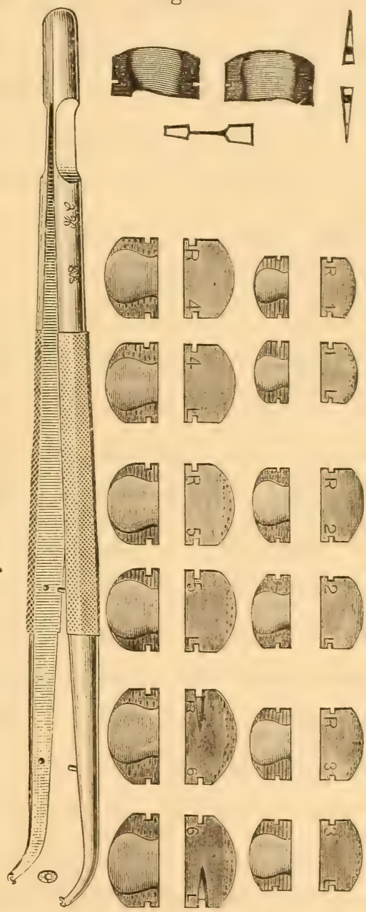
When the lateral walls have been cut away, as was formerly the practice, it is much more difficult to restore the crown to its original form and size than by the method now pursued—retaining the lateral walls and filling flush with them, and also protecting the edges by the filling.

It is claimed that the difficulty of filling this class of cavities is much diminished by the use of the matrix. This appliance, in its present form, is the device of Dr. Lewis Jack. He gives the following description of it and its use :—" These little affairs are made of a variety of shapes, sizes, and thicknesses. They are formed of slightly wedge-shaped pieces of steel, and are, as the cut designates, hollowed out at their thicker edge, which depression terminates at the thinner edge. At the part of the depression designed to give shape to the buccal edge of the filling, the cut is generally abrupt and deep; at the inner portion it is more shallow and more inclined. It will be observed that the depression widens as it passes toward the thinner edge, to follow the usual form of proximal cavities. The lower and thin edge is rounded, to outline the curved margin of the cervical walls, and to effect pressure upon either the gum or the appliances used to stop the escape of mucus and blood from this tissue.

" The plain parts of the face are file-cut, or coarsely draw-filed. The reverse side is in most cases plain and smooth, excepting a small portion at the thin edge, which is file-cut. . . . At each end a square cut is made, that the ends of the plier for adjusting them will fit into. . . . Quite a number of pairs are necessary to meet the requirements of the differ-

ing cases; but for the ordinary-sized simple proximal cavities, a dozen pairs, varying in width, in thickness and in size of depression, are all that I have found necessary. . . . The character of the modifications that should be made in these will depend somewhat upon the desired end, since either a flat, contour, or excessively convex surface may be produced at the pleasure of the operator, or to suit the needs of the individual operation, by varying the form and depth of the depression."

Fig. 88.



The ordinary forms of these appliances are represented by Figure 88.

Some additional description of the matrices, and the method of using them, will be given in the Appendix, Sec. D.

A piece of polished metal, of the proper thickness,

may be placed back of the cavity against the adjoining tooth, introducing the filling, and consolidating it firmly up to this piece of metal. The lost portion of the crown being thus restored, the metal is then removed, and the filling dressed off and finished in the manner described heretofore.

But when the opening is made by cutting in from the masticating surface, the entire opening made in the tooth, both by the decay and the operation, will be completely filled, and the form of the tooth entirely restored; the filling will then present a proximal and crown surface. When the teeth, molars and bicuspids, are decayed upon their contiguous sides, the cavities in both may be prepared as already described; the proper separation and excavation having been made, both may be filled together, the gold extending across the space, and after being filled up flush with the masticating surfaces, the separation is effected by dividing the gold with a separating file. Thus, each cavity is completely filled, and there is always gold enough upon the proximal parts to secure a complete finish. This method is not always practicable, as, for instance, when there is a large space, or when it is not desirable to fully restore the form of each tooth; but occasionally it may be used with advantage. The labor, tedium, and difficulty of manipulation are increased the farther back in the

mouth the decay is situated. The modifications of this class are the same as those of the third class of cavities, and, except the second modification, are susceptible of the same methods of filling.

Special Cases.—The first case that we shall consider here, consists in a complication of proximal decay with decay on the buccal or palatal portion of the tooth, thus undercutting one of the crown angles. Sometimes these decays are on both sides, in the form of transverse grooves, meeting at the corner of the tooth. In such cases, if the pendent crown angle of the tooth is firm and strong, the cavities may be formed in the proper manner, and filled without interfering with the masticating portion of the tooth at all; but if the pendent portion is friable, it should be cut away, and the corner built up with gold. The method of forming the part to be filled will depend on the extent of the decay. When this is large, a greater number of retaining-points will be required than when it is small; and these should be located at such parts as will make them most tenacious of the gold, and best conserve the strength of the tooth. The filling may be built up so as to restore the original form of the tooth, thus presenting three surfaces, the proximal, the buccal or palatal, and the masticatory; or, it may be made with a single slightly convex surface, adapted and finished

most completely at all its borders. This kind of filling can be made only with cohesive gold.

The palatal portion of the crown broken away, leaving the outer portion standing—pulp not exposed.—The tooth in such case is decayed away, so that the floor of solid dentine is near the margin of the gum, the labial third of the crown still standing. The decay having been all removed, four or five little pits should be made on this floor, as near its circumference as practicable; and a small groove may be cut from one of these pits to another all round near the edge of the floor. Then two little pits should be made at the base of the standing portion of the crown, if practicable, without interfering with the pulp, provided it is still living. The tooth thus prepared and properly protected by the use of the rubber dam, the filling may proceed.

For building up a crown of this kind, only cohesive gold can be used; and this should be of the best preparation, and in the most perfect condition, since it is important that the different portions of the filling be most thoroughly united. The instruments employed in the operation should be of the best kind and in the best condition, the serrate points being definite and sharp, though not too long; those with four, six, or eight points may be advantageously used for packing the gold. But care must be exercised

lest these fine points be turned; for when that is the case, the instrument is liable to displace the portion of gold, and thus break up its first attachment during the process of consolidation; and when this is broken, the piece of gold cannot again be made to adhere as perfectly as before.

With everything thus in readiness, the retaining-points are to be all filled, the gold extending from one to the other; this is then to be built all over the bottom of the part to be restored, projecting a little beyond the periphery, and being perfectly consolidated there, and kept somewhat higher round the border than in the centre. The gold should be built up in this manner till the crown is large enough, after dressing, to give the desired size and form. In finishing up, the aim should be to restore as perfectly as possible the lost form of the tooth. The adaptation of the gold, too, to the standing portion of the crown should be most complete; imperfection in this respect impairs the appearance of the work, and jeopardizes the security of the operation.

Occasionally the crown of a molar tooth is found decayed off all round, almost to the margin of the gum, the pulp having previously receded so as not to be exposed. It is in such case desirable to restore the lost portion of the crown, and make a masticating surface such as shall antagonize properly

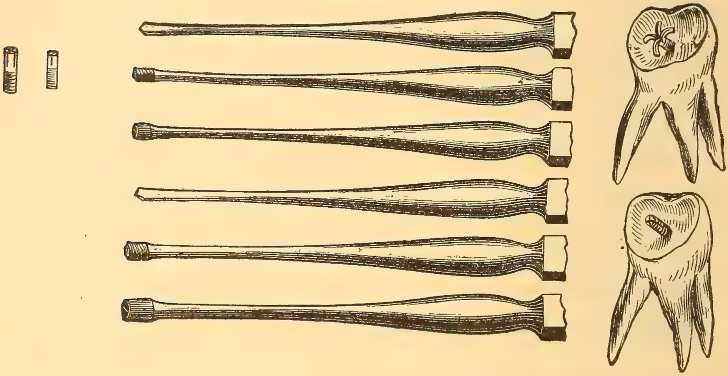
with the teeth of the opposite jaw. As yet, there is no other method of accomplishing this than by building it up with gold—cohesive gold foil, or crystal gold. In the preparation for this crown of gold, the edge should be dressed smooth and even all round the tooth; then six or eight deep pits should be made at different angles on the base thus prepared; and they should be bored with a drill larger than is commonly used for retaining-points. These pits may be slightly enlarged within. The method of building up the crown is just the same as that described for building up part of a crown, the pits being first filled, then joined together, and the gold extended all over the part to be covered by the filling. In extending the gold from a retaining-point or points, it is necessary to build up to a considerable thickness above the orifice of the pit. The portion of gold extending along on the tooth from the pit should be quite thick and firm, so as not to curl up from its position, on the addition of subsequent portions. Every particle of gold, indeed, should be so manipulated, that it will securely maintain its first position. The permanency of the operation will depend very much upon this precaution. The gold should extend somewhat beyond the circumference of the tooth all around, in order to a thorough adaptation and finish.

The foundation thus prepared, and kept free from

moisture, the crown is easily built up by the ordinary method of packing the gold. Any desired shape can be given to this artificial crown; but, of course, that which most nearly resembles the form of the natural crown is in all cases to be desired. The masticating surface of this gold crown is to be formed from the indications given by the antagonizing teeth. Such crowns will wear for years, and perform all the functions of the natural organs. Artificial crowns of this kind have been attached to the tooth, by screwing into the pits small pieces of gold wire at different angles, and then building up round and between them with the gold foil, on the principle already described, thus making these wires serve as so many anchors for fastening the work. The use of screws for securing fillings in these extreme cases was suggested, and perhaps occasionally used, more than twenty years ago, by Dr. W. H. Dwinelle. But during the last four years their practicability has been more fully demonstrated by Dr. Mack, who devised a set of instruments by which small gold screws can be very readily introduced wherever they are required. These screws, as made by Dr. Mack, are screw-cut the entire length, except a small portion of the outer end, which is made flat and wedge-shaped; upon this flattened part the screwdriver acts when the screw is introduced.

Something additional in this direction seemed desirable, and to meet this want, Dr. E. Osmond, about four years ago, made an improved screw, and constructed a set of instruments for introducing it. These are represented in the following cut.

Fig. 89.



These screws are made of twenty-carat gold, annealed and split about half-way, once or twice, so as to form two or four arms. These are opened and turned down, as may be necessary after being inserted.

They are made of different sizes, to meet the requirements of different cases, and the instruments are adapted to the different screws. The teeth represented in this cut show large converging cavities, in which the screws are fixed, ready for the attachment of the filling.

It has been suggested that making barbes on the

screws would give greater security to the filling than the plain screw, yet with Dr. Osmond's screws the utmost security is attained. Of course cohesive gold is always to be used with this kind of anchorage.

Security of attachment of these large fillings may in many cases be quite as well attained with the foil alone. But good tooth-structure and properly-located and well-formed anchorages are very important.

Filling large cavities on the labial surfaces of the superior incisors.—These cavities are usually superficial, and frequently co-extensive with a considerable part of the surface of the tooth. A method of filling them, somewhat novel, though not without merit, has been introduced to the notice of the profession by Dr. Volck, it having been first suggested to him, however, by Dr. Maynard. It consists in filling up the cavity principally with a piece of enamel, as near the color of the tooth as possible. The cavity, when nearly round, should be formed with a wheel bur of the proper size; and after having been thus reamed out, a slight undercutting should be made all round with an excavator. Then a piece of enamel being selected, it is dressed to a proper thickness, which should be slightly greater than the cavity's depth, and to a perfectly circular form, its size being such as to let it drop, with a little play, into the cavity,

and the edge of it beveled from without. For fastening this in the cavity, roll a strip of several thicknesses of gold foil round its edge, and add as much as can be forced in with it. Thus prepared, set it in place in the cavity, and then condense the gold down into the groove all round with a thin-pointed plugger, more gold being added, if necessary, to fill the groove completely full. Afterwards, with the file, stone, and burnisher, dress off the whole to a proper level with the surrounding tooth, finishing very carefully with the burnisher. The unsightliness of a large gold filling on a front tooth is thus obviated, no metal except that composing the ring of attachment in the groove being exposed to view. It is a beautiful operation, and one whose successful accomplishment will require considerable constructive talent and skill.

A better method of performing this operation, for many cases, at least, is by setting a porcelain filling or block in oxy-chloride of zinc. The cavity should be prepared as usual, the borders neatly trimmed, and made as free as possible from irregularities. Select a section of a porcelain tooth, as near the color and surface conformation of the tooth to be filled as possible; then fit the piece to be supplied carefully, making it to conform to the cavity as accurately as possible; it should be a little thinner than

the depth of the cavity. The cavity now being secured against moisture, and made perfectly dry, oxy-chloride of zinc, or better, perhaps, Guilloi's cement, because it hardens less rapidly, should be prepared of such a consistence as to permit the accurate adjustment of the porcelain filling. This, after being put in place, should not be disturbed nor moistened till the cement is well set. It is better to cover the joint with wax or varnish, and let it remain a day or two before attempting to dress or polish the porcelain; if, however, the work has been perfectly done, nothing else will be required.

An operation performed in this manner is preferable to a filling of gold for this class of cavities; it is less apparent to the view; indeed, when a proper selection has been made, and the adaptation is good, it will not be visible at all except under the closest observation; and usually the tooth will be as well protected, and in many instances better, than by the common method of filling.

The use of platinum and gold foil together, as suggested by Dr. Black, for filling these cavities, is better than gold, so far as appearance is concerned; the striking contrast between the color of the gold alone and that of the tooth is materially relieved.

CHAPTER VIII.

PATHOLOGICAL CONDITIONS.

Hitherto, in the consideration of the treatment of caries, the subject of the vitality and pathological conditions of the teeth has been intentionally omitted. It now remains to describe the diseased conditions to which the teeth are subject, and the treatment which those respective conditions indicate. This is an important department of the practice, since upon skill in this, as well as upon the manner of performing the work, the success of the operation depends.

Premising that our remarks on this branch of the subject are predicated on the fact admitted, that the teeth possess vitality, we proceed to consider the pathological conditions to which, in common with all vital tissues, they are liable. There is but one diseased condition of living dentine, anterior to decay, that presents any considerable difficulty in the ordinary operation of filling teeth, and that is, inflammation, or exalted sensibility. This condition was referred to in the remarks on the treatment of caries, as being one that most generally accompanies decay of the

teeth. Whether or not this affection is real inflammation, is a point that has been considerably controverted; and the assertion has been made that it is of no consequence whether it is or not, provided we understand the true method of treating it. This, however, is not to be so readily conceded; for the confession that we do not know what to call a thing, generally implies an ignorance of its character and phenomena. While the term *inflammation* conveys a more definite notion, the phrase *exalted sensibility* is very vague in meaning. That it is true inflammation, is the opinion of our best dental writers.

The dentine is endowed with the functions of absorption, nutrition, and secretion, modified somewhat by the peculiarity of the structure—characteristics that always imply a susceptibility of inflammation. In inflammation of the soft parts there are present various indications,—as, pain, redness, swelling, and increased heat. But in dentine, on account of its peculiar structure, all these indications cannot be manifested: for instance, redness, since the red globules do not circulate through it; nor swelling, since the structure is dense—devoid of mobility; nor perceptibly increased heat, since the circulation is of too low a grade. But one of the most definite indications of inflammation, namely, exalted sensibility, is present here in a very marked degree; and there are

various other circumstances that indicate this condition to be real inflammation: the same irritating causes that induce inflammation in the more highly organized parts, occasion it in the living dentine. This condition of the teeth is always affected by a general inflammatory diathesis, and their sensitiveness, when there is this general tendency to inflammation, is always increased, and local treatment in such case will commonly be inefficient; a modification of such a condition of the system produces a corresponding change in the affected teeth; and those remedial agents which are employed in the topical treatment of inflammation elsewhere are successfully used in the treatment of inflamed dentine. From all these circumstances we infer that this affection of the teeth is a real inflammation.

As has been already remarked, the only definite and direct indication of inflammation of the dentine is exalted sensibility, though this is not an immediate consequence of that condition, independent of external circumstances; for the pain resulting directly from inflammation in the soft parts is not experienced here, by reason of the low grade of vitality and the feeble circulation. But the teeth in a state of inflammation will suffer pain when subjected to sudden variations of temperature, whether induced by the air, by fluids, or by contact with any hard substance;

and when subjected to the influence of agents that irritate the nerve-tissue anywhere, such as acids, some alkalies, salts, &c. In regard to degree, extent, and location, this affection exhibits a variety of manifestations; in degree, from the most mild to the most intense—sometimes fixed at a uniform pitch of pain, and sometimes passing through the gamut of torture up to the most acute anguish. The character of the affection is modified by differences in the organic structure of the teeth, those most vascular and most highly organized being most readily and most extensively involved; and therefore the teeth of the young are generally more liable to it than those of the old. So, too, persons of a plethoric or a strumous habit, as well as those in a febrile condition, are peculiarly predisposed to this affection. Sometimes irritation or disturbance of other organs of the system sympathetically or secondarily induce inflammation of the dentine. Uterine irritation frequently does so, and hence, during pregnancy, or a protracted suppression of the catamenia, the teeth are very liable to be thus affected, and, if decayed, to become very sensitive.

Inflammation of the dentine will sometimes be exhibited in various degrees in different teeth in the same mouth at one time. This is owing to differences in the organic structure of teeth developed at

different periods of life, to differences of their location in the mouth, and to differences of exposure to those agencies which are apt to induce the condition. As to the extent of this inflammation, it may be confined to a thin lamina of bone immediately beneath the decomposed portion, or may extend deep into the body of the tooth, and, indeed, in some cases, pervade the dentine of the entire crown. This latter extent, however, is not likely to occur, unless there is a general predisposition: if it is produced by local causes, it will not, in general, penetrate very deeply into the dentine. Most commonly, the greatest sensitiveness is at the union of the dentine with the enamel; but sometimes it is confined to a small point within the cavity, either because there is a concentration of nerve-fibrils there, or because there has been a determination of the irritating influences to that point—the former being probably the more frequent. The greatest sensitiveness, as already remarked, is generally at the surface of the dentine, because that is the termination of the nerve-fibrils which ramify the dentine, and wherever nerve-fibre terminates, there always we may look for exalted sensibility. Hence it is that decay of the teeth is often found to be more sensitive in its incipient stages than when it has become more advanced.

Treatment of Inflamed Dentine.—There are several

methods of treatment that may be employed to remedy this condition. In many cases, where time and circumstances will permit, a removal of all irritating agents from the affected parts will enable nature to effect a restoration to health. All decomposed dentine is to be removed from the cavity, every exciting influence in it withdrawn or neutralized, and the cavity itself perfectly filled with some non-conducting material, so as entirely to exclude all foreign substances. So far as non-conduction of heat is concerned, there is perhaps nothing better than "Hill's stopping;" or in some cases tin or gold may be used; but when either of these is employed for this treatment, some non-conducting substance should be placed between the filling and the sensitive dentine. The length of time necessary for the restoration of the affected part, under this treatment, will be much varied by circumstances. The cases susceptible of this kind of treatment are those in which there is no constitutional predisposition, in which the vitality is strong, and the recuperative power vigorous. When the temporary fillings are made of metals, the patient should be careful to protect them from sudden changes of temperature. For such fillings, in case they are required but for a short time, a lock of cotton saturated with a solution of gutta-percha and chloroform may be used.

But in cases in which the vitality is low, the affection chronic, the exciting cause highly irritating, and the general diathesis inflammatory, nature, unaided, will not affect a cure. In such circumstances, therapeutic treatment is indicated. The agents employed in topical treatment may be divided into two classes: first, resolvents, or those which have for their object an entire restoration to health of the part affected; and second, escharotics, or those which have for their object the death of a portion or all of the diseased part. The former class of agents is of course preferable, when the object can be promptly accomplished by their use, and especially preferable to those agents which endanger the vitality of the whole tooth. In very many cases in which topical applications are indicated, constitutional treatment is also required; and this should be of an antiphlogistic character. The immediately adjacent parts, too, as the gums, the mucous membrane, etc., should be carefully regarded. Indeed, treatment of the gums by counter-irritation, depletion, and various preparations, such as the conditions may indicate, will often be found pre-requisite to a successful treatment of sensitive dentine by topical applications.

There are very few agents used simply as resolvents. The properties characteristic of this class of agents are tonic, stimulant, sedative, and astringent.

Capsicum may fitly represent the stimulant; Peruvian bark, and gum myrrh, the tonic; tannin the astringent; and opiates the sedative principle. Astringents, stimulants, and sedatives all tend to counteract inflammation. The agents of this class are not very extensively used in the treatment of dentine, not because they are not ultimately efficient, but because their action is less vigorous than that of some other agents. When, however, time and circumstances will permit, mild treatment, if efficient, is to be preferred.

But there are many cases in which, for want of time, something more rapid in its action is required. Of this character is the second class of therapeutic agents, namely, escharotics, or those which by their action destroy a portion of the tissue with which they come in contact. It may be well to notice, separately, the preparations commonly used for this purpose.

Tannin, or Tannic Acid.—This is the active principle of vegetable astringents, and is found most abundant in nutgalls. It unites with albumen, fibrin, and gelatin, forming with them insoluble tannates. Its medicinal influence is almost necessarily topical, since the promptness of its action on albuminous substances, and the insolubility of its compounds with them, prevent its admission into the general circula-

tion. The action of tannin on dentine has been already explained. Either its aqueous or its alcholic solution may be employed, the latter being the better and more convenient preparation. It is however recently used by solution in creosote and glycerin, which constitute a very valuable preparation. Where tannin is applied to dentine, there is formed a tannate of albumen, which, being insoluble, protects from irritation, and probably incites to healthy condition the living parts beneath it.

Creosote, or Carbolic Acid.—Formerly, creosote was obtained by distillation of wood, and differed somewhat from that in present use, which is prepared by distillation of coal tar. It dissolves freely in alcohol or ether, and sparingly in water; its action may, therefore, be modified by dilution. Creosote produces its caustic effects by its affinity for albumen and gelatin, with which it forms insoluble compounds; and from its *modus operandi*, it is evident that the popular opinion that it promotes decay of the teeth is an error.

Nitrate of Silver.—This salt is a powerful caustic, whether applied to soft parts or to bony tissue. Its action is somewhat complex. Nitric acid is liberated by the decomposition of the salt when in contact with organic matter. Nitrate of silver has a strong affinity for albumen, uniting with it without difficulty;

and the compound thus formed is soluble in nitric acid. When the nitrate is applied to the skin, the immediate result is a whitish mark caused by a union of the salt with the albumen of the cuticle; but this soon turns black, by the reduction of the salt and the liberation of the oxide of silver, when for each atom of this set free there is liberated an equivalent of nitric acid. There is here, then, an agent that acts promptly on the gelatinous portion of the tooth, destroying its vitality to the extent of the combination which takes place, and that, by the decomposition of part of the salt, and the consequent liberation of part of the acid, also acts with energy on the calcareous portion. The compound formed by the nitrate with the organic constituents of the tooth, is insoluble except with a few substances, and therefore protects the subjacent parts; and the precipitation of the reduced oxide on the surface, it is claimed, affords some additional protection. The insolubility of the compound above mentioned prevents an absorption of the nitrate by the dentine, and renders its action necessarily superficial. When the nitrate is neutralized by a union with it of an equivalent of the constituents of the dentine, no further chemical action is possible. The compound formed by this union is soluble in a dilution of the nitrate; and if this be applied in too great a quantity, there may be a larger

loss of substance than is desirable or at all necessary; for as long as free nitrate remains in solution in the cavity, the insoluble compound is not precipitated, and the surface is therefore exposed to the continued action. It is preferable to employ the nitrate in the solid state, or, when this is not practicable, in a concentrated solution, and small quantity, rather than in a copious dilution and repeated application.

From the observations already made, it is quite evident that no harm can result to the tooth from a proper application of this agent, beyond the portion of it immediately acted upon. The nitrate cannot be absorbed by dentine, but it stimulates the subjacent dentine to more healthy action; though some maintain that it is not as efficient in this respect as some proper chloride. It acts to a greater depth than tannin or creosote, but not so deep as chloride of zinc, nor with so much pain. Great care should be exercised that its contact be permitted no further than its action is desired.

Chloride of Zinc.—This agent has been extensively, though much less now than formerly, used in the treatment of sensitive dentine. It exerts an antiseptic and disinfectant, as well as an escharotic, influence. In its operation it decomposes; the chlorine obtaining hydrogen by decomposition of water, hydrochloric acid is formed; this unites with the

calcareous elements, and breaks down the animal constituent as well. It is milder in solution than in solid, and less efficient and less painful. It is soluble in water, alcohol, ether, or chloroform. The etherial and the chloroformal solutions are, in their action, least painful of all the forms in which this chloride is applied. The union of this agent with the gelatinous constituent of the tooth is also more prompt in solution than in solid. The ether and the chloroform may lessen the pain by their anæsthetic influence. In the use of the chloride, or any other active caustic, it is important to bear in mind the exalted vitality which follows its application; and the operation should be immediately performed. In the teeth of young persons, or those in which the animal constituent greatly predominates, the vitality will be more promptly aroused than in those of an opposite texture, and the change, too, will be greater. If the inflammation is confined to a thin lamina, it will be almost instantly allayed by the application of the chloride, and the cavity may be excavated as though there had never been exalted sensibility in it; but if the operation be delayed any considerable time, the tooth will often be found in a worse condition for excavating than before the application. The remarks on absorption under the head of *nitrate of silver* apply with equal force here: there is not the least danger from this

source; indeed, there can be none, even when the chloride is applied to the soft parts.

Terchloride of Gold.—Of this preparation the etherial solution only has been employed. This acts with great promptness on the dentine, forming an insoluble compound with the gelatinous elements, and the chlorine performing its role upon the calcareous portion. On account of the promptness with which this agent operates, neither the pain nor the disturbance of the subjacent parts caused by it is great. This substance is very liable to decomposition. By exposure to air or light, the gold is precipitated in the metallic form. But protected from these, it may be preserved for a long time. This agent will not be absorbed by the dentine.

Arsenious Acid.—The *modus operandi* of this agent is involved in obscurity. In regard to its topical action, Professor Bache says: "Arsenious acid, when it produces the death of a part, does not act, strictly speaking, as an escharotic; it destroys the vitality of the organized structure, and its decomposition is the consequence. The true escharotic acts chemically, producing a decomposition of the part to which it is applied,—a state incompatible with life." Pereira says: "Though employed as a caustic, yet the nature of its chemical influence on the animal tissue is unknown; hence it is termed by some a dynamic

caustic." Its escharotic power certainly bears no proportion to its devitalizing power; but it is probable that it forms definite compounds with some of the constituents of living tissue; and if so, these compounds appear to be readily and rapidly decomposed, so that the acid becomes again free to attack, with similar results, the subjacent parts. The topical application of arsenic is liable to be followed by constitutional effects.

All dentists are aware of the fact that a tooth-pulp may be destroyed by arsenic, through a wall of considerable thickness. To accomplish this, the agent must in some way penetrate the substance of the dentine, and its vitality is destroyed so far as it is thus penetrated; indeed, the vitality of the whole crown of the tooth, both dentine and pulp, is often destroyed by the use of this remedy, applied even to a small cavity. Exalted sensibility of dentine is subdued by this agent, more by its devitalizing than through its chemical energy. It is soluble in creosote and similar oils, and to a considerable extent in alcohol and water. It is absorbed much more rapidly when applied in solution than in solid; and the more vascular the dentine, the more rapid and extensive will be the absorption; and on this account there is great risk in applying it to the teeth of young persons, or to any teeth that are highly wanting in den-

sity; indeed, it will destroy the vitality of very dense teeth. The manner in which it passes into the dentine is not very definitely understood. It is very certain, however, that in more highly organized parts it is carried through by the circulation, and also may be taken up by imbibition. In either of these ways it may pass into the dentine, and so far as concerns the results, it matters not in which way. It is enough to know that there are well-defined cases of its specific effect on the constitution, after having been applied to dentine, demonstrating that it must have been taken up by the circulation; and also cases of its manifest effect on the periosteum in a short time after having been applied to the cavity of a tooth the pulp of which is dead—thus proving that it must have been absorbed by imbibition.

If arsenic is ever employed in the treatment of sensitive dentine, it should be suffered to remain in the cavity but a short time,—from one to three hours,—and then the part with which it was in contact should be very thoroughly excavated. In deciding in what cases it is proper to use it, there is need of careful discrimination as to the tooth's structure and density, for injurious results have sometimes followed its application, notwithstanding the utmost care; if it has once been absorbed by the dentine, antidotes will avail nothing. On the whole, there-

fore, it is better to refrain from its use altogether in the treatment of sensitive dentine.

Alkaline caustics have been to some extent used for the treatment of this affection. A preparation made after the following formula is said to relieve some cases very promptly: Take Canada balsam and slacked lime, and having made them into a paste, fill the cavity partially full with it, and permit it to remain until the object is accomplished.

The sensitiveness of dentine may be obtunded by friction on the affected part with a smooth burnisher. This method, however, is applicable only to those cases in which there is room to use the instrument. On the surfaces of the teeth, where there may be sensitiveness, it is very applicable and very efficient. Simple pressure, without friction, it is suggested, will accomplish the same object, though pressure and friction combined are doubtless more efficient.

During the last three or four years, various applications have been introduced, and used to greater or less extent, for the relief of sensitive dentine during the operation of filling. Moistening a cavity with creosote, carbolic acid, carvacrol, or oil of cloves, at the time of operating, and especially in excavating, will in many instances greatly mitigate the pain, and in some relieve it altogether.

About two years ago, a nostrum denominated

"Dental Pain Obtunder" was introduced, and used by many in the profession, and in many instances with decidedly good results. With it, however, as with many other things, there was a variety of opinions and experiences.

The use of any of these things, even though they would in any case give temporary relief, do not meet the difficulty in a proper manner, except in those cases in which the affection is very superficial; in every other case the aim should be complete restoration to a normal condition, and this, for the most part, at least, must be accomplished by nature, aided, so far as practicable, by proper systemic and local treatment.

Many suppose that if they can by any temporary obtunding of sensibility introduce a filling, all will be well. This often proves to be a serious mistake, for when a filling of metal is placed on sensitive dentine, the thermal changes very often prevent a return to a normal condition, and in some cases greatly increase the difficulty. In all instances, so far as possible, an entire restoration to a state of health should be effected before filling, or the part shielded by a non-conductor.

CHAPTER IX.

EXPOSED PULPS.

When the pulps of the teeth are exposed, it is usually in consequence of decay, but sometimes of a gradual wearing down of the organs in mastication, in other cases by chemical abrasion. When the pulp of a tooth is found exposed, the course of remedy to be pursued will be indicated by the following considerations :—

1st. The constitution and the vital energy of the system.

2d. The condition of the mouth and teeth.

3d. The condition of the pulp.

4th. The size of the orifice at which it is exposed.

5th. Whether the exposure is of recent or of remote origin.

6th. If in a tooth of more than one root.

7th. The position of the tooth in the mouth, and that of the decayed cavity in the tooth.

The propriety of attempting to preserve the vitality of the pulp after exposure has been questioned. Some take the position that after the development and for-

mation of the tooth, the pulp is no longer of any use, and may, without damage, be dispensed with; while others maintain that when the pulp is destroyed, the tooth is no longer of any value. The truth is perhaps a medium between these extremes. The pulp of the tooth is valuable in the economy, or nature would dispense with it. Analogy teaches that it would not be retained longer than it could subserve some beneficial purpose. But it is also true that a tooth may be retained and perform its proper function for a long time after the destruction of its pulp, notwithstanding it is in a less perfect condition; though it is always desirable to preserve the life of the tooth when practicable, for the crown depends on the pulp for its vitality, and living dentine presents more resistance to decay than dead; besides, a dead tooth never exhibits the bright, life-like appearance of a living one. The parts about a dead tooth, too, are far more liable to disease than those about a living one. These are only a few of the considerations for retaining the pulps of the teeth.

It has been maintained that the structure of the tooth-pulp is of such peculiar character, and so susceptible of diseased action, that after it has become affected, though but slightly, it cannot be restored to a healthy condition. We see no ground, however, for such an assumption, except it be in the imperfect

treatment which this organ so frequently receives; for the fact of its delicate structure does not necessarily imply an impossibility of restoring it from disease. The pulp of the tooth is endowed with such functions as ordinarily render living tissues susceptible of treatment for abnormal conditions, such as circulation, nutrition, absorption, and a distribution of nerves. The success attending the methods of treating exposed pulps practiced by the dental profession during the last few years is a source of more encouragement than a thousand theories.

Treatment of Exposed Pulps.—In cases where the conditions are favorable,—the constitution good, the pulp but recently exposed at a small orifice, and in a healthy condition,—treatment may be instituted with almost absolute certainty of success. If there is no inflammation or irritation, therapeutic treatment is not indicated; but the decay should be removed and the cavity formed without wounding the pulp, if possible; though a slight wound is of no serious consequence, for immediately after the hemorrhage ceases, the operation may proceed as though the pulp were intact. There have been suggested various methods for protecting the pulp in cases of this kind; formerly, the capping of pulps was very extensively practiced, by which a shield was thrown over the exposed point, so as to prevent the filling from coming

in contact with it. Various materials have been suggested and used for caps; but gold and lead were formerly used for this purpose, especially when the object was to form an arch over the point of exposure. These caps are cut out of thin gold plate, or thick sheet lead, of the proper shape and size, and stamped with a convex punch, thus receiving such a concavity as fits them for covering the exposed pulp without touching it. A little groove, of depth sufficient to hold the cap, and prevent it from being displaced by the introduction of the filling, may be made in the dentine all round the orifice of exposure. The cap is then to be adjusted to its position in the cavity, having been previously touched round its edge with adhesive wax; the filling is then introduced in the usual manner, carefully, so as not to displace the cap; and if this is of lead, great caution is to be observed in condensing the filling above it, since it will be easily compressed.

The therapeutic influence of lead on exposed pulps is supposed by some to be definite and decided; but though lead is a less perfect conductor of heat, and in this respect is better than gold, and though, in the capacity of a pulp-cap, its indestructibility is probably quite sufficient, yet, if no change takes place in it, it is not very apparent how it exercises any therapeutic action on the pulp. Experience, however, proves

that the success is quite as good in the use of lead caps as in those of gold; and the former are more easily applied.

Another method of shielding an exposed pulp is, to form an arch over it by the filling. This operation is performed by beginning the filling at that side of the cavity most easily approached, building on the gold from the points of its attachment almost to the point at which the pulp is exposed, and then attaching from one point to another without permitting the gold to come in contact with the pulp. Care should be taken that the gold present as smooth a surface to the pulp as possible. When the orifice of exposure has been well covered and protected, the remaining portion of the cavity is filled as usual. This method of forming a protection over a tooth-pulp possesses no advantage over the ordinary cap; and being much more difficult, it is impracticable in any but skillful hands.

This practice with exposed pulps, however, has within the last few years been almost wholly abandoned, for the following reasons: because it so frequently failed to accomplish the object, and because a better method of treatment has been discovered. It was found that, under that practice, many cases which at first promised well did not preserve the life of the pulp, though the fatal results were not always immediate—a year or two, and in some instances a

much longer period, intervening between the operation and the death of the tooth. In favorable cases, the pulp, even after exposure, will, if protected from the influence of foreign substances, throw out a bony deposit, and even close up an orifice of exposure, thus forming for itself a natural shield. It is suggested that the capping operation is not the best protection for facilitating this process. It is probable that in some cases the space between the cap and the pulp, though it were large, would be filled with lymph; and even if it were thus filled, a bony deposit might not be made; and if it were not, it could not fail ultimately to prove injurious to the pulp. But if the space should not be filled with lymph, the difficulty would be equally as great, since the pulp would protrude through the vacuum beneath the cap, and necessarily become diseased, since it would be irritated by its contact with, and its pressure against, the sharp edges of dentine at the orifice of the cavity; and it may remain thus diseased for a long time, or die at once. Thus it is, no doubt, that the great majority of failures occur under this kind of treatment. In order to obviate this difficulty, it has been suggested that the space under the cap be filled with some appropriate substance, as a thick solution of gutta-percha and chloroform, or a small pledget of cotton saturated with collodion.

The frequent failures which occur in capping pulps have incited the profession to seek some other method of treatment. A vacuum above the pulp being objectionable, some suitable material is employed as a shield for this, being placed on the orifice of exposure, in contact with the pulp; and the filling is then introduced without pressure upon the point of exposure. There are several substances that have been thus employed, the chief of which are asbestos, oiled silk, collodion, gutta-percha, Hill's stopping, and os artificial. The material for this purpose should be a non-conductor of heat, should not be subject to decomposition when in contact with the pulp, and should present a smooth surface and be easily adapted. In shielding a pulp in this manner, it is important that pressure be not made upon it; and there is not much liability to this, where the orifice of exposure is small, but where it is large, much care is required in the introduction and consolidation of the plug. The opinion has been entertained by some that the pulp of a tooth will not tolerate any foreign substance in contact with it; but facts refute such an opinion. By this kind of protection for a pulp, secondary dentine is more likely to be developed.

A very perfect covering for an exposed pulp may be made by dropping on it a little collodion or solu-

tion of gutta-percha, and after the evaporation of the ether or chloroform filling over it. This method has the advantage of completely filling and occupying the space, and exactly conforming to the part, which is an important requisite in this operation. When the exposure is at a large orifice, if the pulp is healthy, and the constitution of the patient good, the same general course of treatment may be adopted, except that more care and skill will be necessary in the performance of an operation. Indeed, it is difficult to make a good operation in cases of this kind, using for the covering only a soft or flexible material.

A method of operating that is probably more efficient than any other, is to prepare the cavity as already directed, place on the pulp two or three drops of collodion or solution of gutta-percha, letting it partially stiffen, and then over this fit a gold or lead cap as exactly as possible, so that it shall rest on the solid dentine, far enough from the orifice of exposure to preclude it from injurious influence on the pulp. On this, the filling is introduced as usual, care being had not to displace the cap, which in all cases should have a seat made for it, formed at the time of the preparation of the cavity.

When the pulp of a tooth becomes, by exposure, inflamed or diseased, some more special treatment is

indicated, and usually it is therapeutic. In every such case, the treatment will contemplate either the preservation of the pulp, when the circumstances will warrant; or when they will not, then its destruction and removal. The former of course is always to be preferred, where practicable. Some of our best operators very strongly denounce the wholesale destruction of the pulps of the teeth, practiced by many; while some dentists never attempt to restore and preserve them at all, however slightly diseased. This, as elsewhere intimated, is an erroneous practice; for there is no obvious reason why the pulp of a tooth may not be restored from disease to health as readily as other parts, endowed as it is with circulation, nutrition, absorption and the distribution of nerves. The particular kind of treatment required in any given case, however, will be controlled by various circumstances, such as the nature and extent of the disease, whether it is of chronic or acute tpye. When the irritation or inflammation is but slight, and is kept up solely by the contact of irritating substances, restoration of the pulp may be effected by a removal of these irritating causes, and protection of the pulp against their further influence: in such case, nature, unaided, affects the restoration. In a feeble constitution, the pulp, though but slightly affected, will require topical therapeutic treatment; and meanwhile

general treatment may be employed to give increased tone to the system. In the local treatment, neutralizing agents should be applied first, and afterwards such as will counteract and reduce inflammation, especially if this is in an active state. But if the pulp is in a morbid condition, with retarded circulation and a tendency to enlargement, active and stimulating applications will be indicated, and in some cases escharotics, such as nitrate of silver, chloride of zinc, and chromic acid, the latter especially where there is a tendency to prurient enlargement of the pulp. The therapeutic principles embraced in astringents, tonics, stimulants, and escharotics, are mainly to be relied upon in the topical treatment of exposed pulp.

The length of time requisite for this treatment will vary with different cases. In the case of a recent acute inflammation, the process of restoration may be completed in two or three days; while in other cases, where the difficulty is of long standing and of a more complex character, it will require from a week to two months. The systemic condition of the patient also exercises a great modifying influence upon the treatment. Leeching and counter-irritation of the gums are sometimes resorted to in this treatment; but it is rare that any definite beneficial result ensues. Depletion of the pulp itself may often be practiced with

decided success: and it may be accomplished either by puncturing the pulp with a fine-pointed instrument, or by excising a small portion of it at the orifice of exposure, in either case avoiding laceration. By this means the distended vessels are relieved; and in many cases, where the difficulty is but slight, immediately after such relief by puncturing, so soon as the hemorrhage has ceased, the tooth may be filled. But if the depletion is by excision, time must be allowed for the recovery of the incised surface—ordinarily from three to ten days.

A method of treatment of exposed pulps—first introduced to the notice of the profession by Dr. Allport, and one which in his hands has proved quite successful—consists in the excision of a portion of the pulp at the orifice of exposure, drawing the edges of the incised part together, and inducing their union, and in this manner closing the wound, when less space is occupied by the pulp than before the operation. After securing this result, the operation of filling the tooth may be performed; the same care being observed, however, as already suggested in cases of exposed pulp.

The employment of pepsin has been quite effective in the hands of some practitioners. The method of application is as follows: with the pure pepsin in powder, and diluted hydrochloric acid, or liquid pep-

sin, form a paste of creamy consistence, that can be readily applied to an exposed pulp.

The cases in which this preparation seems appropriate and efficient are those in which there is débris and offensive matter in contact with and irritating the pulp that cannot be readily removed, either with an instrument or by washing. There is often a film of partially devitalized pulp substance upon and covering the exposed part, that operates as an active irritant to the tissue beneath it; this and all similar substances are dissolved and removed by the action of the pepsin paste; and not only is this accomplished, but the pulp is stimulated to a healthy action.

For the application the cavity through which the exposure is effected should be cleaned thoroughly and dried; then place a drop of the paste on the point of exposure, on this put two or three plies of bibulous paper, then fill the cavity with wax, softened by heat, so that its introduction will not cause pressure upon the pulp. This should remain for from six to twenty-four hours, when it should be removed; the pulp will usually now present, at the orifice of exposure, the bright pinkish hue of the healthy tissue; very seldom will a second application be required.

This condition being attained, the pulp is ready for its covering for permanent protection.

For the proper covering and filling over an exposed pulp, certain indications must be fulfilled:

First. A material must be used that will be acceptable to the tissue, that will in no degree irritate it.

Second. It should be a substance that will not decompose or undergo change when in contact with the pulp.

Third. It must be a material of such consistence as to be made easily to occupy all the space at the orifice of exposure, and yet make no pressure upon the pulp.

Fourth. It should be a non-conductor of heat equal to or beyond the dentine.

Fifth. It should possess sufficient resistance to admit the proper introduction of the best material for filling.

Thus it is apparent that the aim is, and should be, to place the exposed pulp back again in as nearly its normal state of closure as possible. This is the criterion that should guide in the performance of this most delicate operation.

A very good method of accomplishing this was suggested by Dr. J. S. King about the year 1871. Others have claimed that they had used the same principle before.

It consists in placing in the orifice of exposure and on the pulp, after it has been freed from all irritants

and restored to a state of health as nearly as possible, a paste of oxyd of zinc and creosote of a thick creamy consistence; with this the orifice should be completely covered; remove any excess of creosote with bibulous paper; then cover this, and fill the cavity of decay with os artificial or Guillois' cement. So far as the pulp is concerned, this is to be the permanent covering; as to the cavity of decay, this may constitute the permanent filling, or sufficient of the os artificial may be cut away from the cavity to enable it to be well filled with gold, or any other material. This in the hands of many has proved a very successful method of enclosing exposed pulps.

The formation of secondary dentine, by which the orifice of exposure is closed up, has already been referred to; and it has been suggested that treatment to facilitate this process may be instituted. With a view to this, temporary fillings are sometimes introduced. If a shield of secondary dentine is desirable before permanent filling, the best method of securing it is, after seeing that the general recuperative power is in the best condition, to place in the cavity a temporary filling, of such material and in such manner as will be most acceptable to the pulp, and then leave nature to accomplish the work. In many cases, especially in young persons, this process would be facilitated by an administration of bone phosphate.

The pulps of the teeth of the young are more difficult to treat successfully than those of the more advanced in life.

A method of treating exposed pulps with a view of securing a closure of the orifice of exposure by nature, was first suggested and practiced in 1873 by Dr. J. E. Cravens, and consisted of the following treatment:

The exposed pulp should be rendered as nearly absolutely free from extraneous matter as possible, but softened or partially decalcified dentine should remain undisturbed in the cavity. The cavity should be secured against moisture, and kept so during the operation; being thoroughly clean and dry, the pulp exposure should be covered with a paste prepared as follows: Upon a warm slab of ground glass put a drop of Merck's lactic acid; add twice that volume of *magma*, or freshly-precipitated phosphate of lime; then rub till a complete solution is effected. This is lacto-phosphate of lime. To this solution add dry phosphate of lime until the paste is of proper consistence for application. Place this paste directly on the exposed pulp so as to occupy all the space, and yet make no pressure upon it; the cavity may be filled from one-fourth to one-third full of this material; then remove the moisture from the surface of the paste with spunk or some absorbent, then cover

it with two or three plies of bibulous paper, cut to fit the cavity and moistened with sweet oil; press this carefully upon the paste, especially all round the border; then cover this and fill the cavity with os artificial, or its equivalent. Hill's stopping or gutta-percha cannot with safety be used instead of the os artificial, as more or less pressure would be occasioned by their introduction. Dr. Cravens suggests that the pulp should not be treated previously with anything that would coagulate albumen, and indeed should have no preparatory treatment except that already referred to.

This dressing and filling should remain undisturbed for from two to six weeks, and one application is usually quite sufficient to induce bony deposit to fill the orifice of exposure and cover the pulp.

Pain will seldom be experienced after the application of the phosphate of lime as above described, but if it should, the use of sedative treatment, either locally or through the system, will meet the difficulty. In no case should the dressing and filling be removed or disturbed till the allotted time has elapsed. Dr. Cravens entertains the opinion that the phosphate of lime, thus applied, is appropriated in the formation of the new deposits, and that thus the living tissue beneath has coöperation in this process, at least so far as supply is concerned.

Destruction of the Pulp.—There are cases in which an attempt to restore the pulp, even when recently and but slightly diseased, would prove unavailing; so feeble is the vitality that it is destroyed at almost the first touch. Two cases in *apparently* the same condition pathologically, but in different constitutions, will, under the same treatment, exhibit very different results. A pulp in a system with low vital power, that is highly diseased, is but seldom, if ever, under any circumstances, susceptible of restoration; and in such case, of course, devitalization and removal are indicated. This was formerly supposed to be an impracticable operation, for two reasons: first, because it was very difficult and painful; and second, because of the consequences likely to ensue. Then, the operation was attempted only on teeth having one root, and those of cylindrical form; but now, it is performed successfully on all classes of teeth. When destruction of the pulp is decided upon, such means should be employed as will effect the object promptly and thoroughly. Everything should be entirely removed from the pulp-chamber and the canal of the root, for any remaining portion is liable to induce inflammation and suppuration; and alveolar abscess also frequently ensues.

There are two methods of destroying the pulp: the one, by an operation; the other, by the applica-

tion of some devitalizing agent. The choice of these methods will be governed by circumstances, such as the temperament of the patient, the condition of the tooth and parts about it, and the class of the tooth to be operated upon. For patients of a nervous, irritable temperament, to whom a removal of the pulp by an operation would occasion great pain and a severe shock, it would be better to apply some agent to destroy the vitality of the pulp, and then remove it; but, on the contrary, where there is vigor, and a capacity of endurance, it is preferable to remove the pulp at once by an operation. To accomplish this, there are two or three methods of manipulation. In the first place, however, by whatever method it is removed, it should be fully exposed; the orifice of exposure should be as large as the pulp-chamber, and the entrance as nearly as possible on a line with the tooth's axis; hence it will be necessary in many cases to make an opening into the pulp-chamber at a point different from that of the opening caused by the decay. For instance, in the incisor teeth, when the decayed cavity is small, on the side, near the margin of the gum, penetrating to the pulp-chamber, and exposing the pulp, the entrance through this opening into the canal will be almost at right angles with it; and in such case it would be impossible, through this opening, to manipulate freely in the root, and it

would be necessary to make an opening with a drill through the palatal portion of the tooth directly into the canal and on a line with it, which opening should be large enough readily to allow of a removal of the pulp through it, and of an unimpeded performance of all the subsequent operations in the canal of the root.

After the pulp has been exposed by the proper opening, the instrument should be selected for its removal. There are different forms of instruments for this purpose. Some operators employ the untempered, four-sided, barbed broach, thrusting it into the canal as far as possible, then turning it two or three times around, and thus wrapping the pulp round the instrument, when both are drawn away together. This method always occasions considerable pain. Others employ simply the three or four-sided broach, thrusting it through the pulp all the way up the canal, and thus lacerating it and breaking up its structure, so that it may afterward be removed without much pain. Another method, and one which seems preferable to all the others, is as follows: Take a very fine untempered steel wire, round and smooth, not larger than 34 to 36 of Stub's gauge-plate; flatten the extreme point, and turn it to an angle of from thirty to forty degrees; place the end of this against one wall of the canal at the point of exposure of the pulp; press it

steadily up the canal, with its edge bearing against the wall, as far as it will go, and then twirl it suddenly round. Thus an incision is effected near the point of the root, when the pulp with the instrument may be drawn away together; or, if not thus removed, it may be caught with some fine point, and removed with little or no pain. This manner of introducing the instrument, too, causes less pain than either of the others, for there are no sharp edges or points presented in passing the instrument up the canal, to cut or lacerate the pulp. In the removal of the pulp from the teeth of young persons, care should be taken lest the instrument pass entirely through the foramen, at the apex of the root; but with adults there is little or no danger of such an accident.

The directions here given would be quite sufficient, if closely followed, for the removal of the pulps of the six anterior superior teeth. For the removal of the pulps from the bicuspids, the entrance can ordinarily be effected through the decayed cavity. Usually there is some lateral compression of the roots of these teeth; and the canal through the root corresponds in its formation, so that it represents a mere fissure, expanded a little on each side of the centre. It is often difficult, and requires very delicate manipulation, to remove all the pulp from these fissures. A very fine

instrument may be pressed down each side, and yet a portion of the pulp remain in the centre. This difficulty is most fully presented in those cases in which there has been an apparent, though abortive, effort of nature to produce two roots.

The removal of the pulps of the molar teeth is a more extensive and complicated operation. The pulp to be operated upon should be fully exposed, the orifice of exposure being made as nearly as possible of the size of the pulp-chamber; and the instrument to be used should be such as last described, except that it should be much larger, and is to be introduced, in the same manner, to the bottom of the pulp-chamber, and rotated suddenly, so as to cut off the ramifications of the pulp into the roots, thus at one sweep dislodging the entire body of it without laceration. The practice of plunging a large barbed or cutting instrument into the pulp of a molar tooth is painful in the extreme.

The pain of removing the living tooth-pulp may be much mitigated in all cases, and in many prevented altogether, by the use of local anæsthesia. This may be effected by the application of chloroform, or some one of the various anæsthetics that are available, directly to the pulp. The application of cold is quite efficient; this may be effected by the use of ether spray or ice. So extended have become the facilities

for inducing local anæsthesia, that the spray or ice need hardly be employed.

The branches of the pulp in the roots should be removed in the manner already directed for the removal of the pulps from teeth of single roots. The palatal root is very easily operated upon; but as to the buccal roots, there is frequently encountered the same difficulty referred to in speaking of the bicuspids. When a pulp is removed in this manner, the wound commonly heals by first intention, and there is formed a permanent cicatrix.

Actual Cautery.—For destroying tooth-pulp, the actual cautery was formerly employed to a considerable extent, and was at one time a favorite method with French dentists. This consists in heating a wire of proper size to a white heat, and thrusting it into the canal of the root to the apex, the object being to destroy the pulp the instant the wire comes in contact with it. The operation requires much skill, and is attended with many difficulties. It is fraught with terror to the patient; if the temperature of the wire is not at white heat at the time of its insertion, the pain of the operation is most intense; it is liable to leave the parts in such a condition as often to induce inflammation and suppuration, which may involve the investing membrane and the surrounding parts. Besides, by this method, the object

is, at best, no more successfully attained than by others.

The galvanic cautery has been employed to some extent in general surgery, and it is very probably the best form in which the actual cautery can be applied for destroying pulps of teeth.

Potential Cautery.—This term is applied to those therapeutic agents which destroy vital tissue by establishing a condition incompatible with vitality. Many preparations have been employed as topical applications to devitalize the pulps of teeth, but only two or three to any considerable extent. A consideration of the nature and something of the specific action of these agents may not here be out of place. And first, of

Arsenious Acid.—This has been more used, topically, for the destruction of tooth-pulp than all other applications. The first account we have of its use for this purpose dates back to 1836, when it was applied by Dr. Spooner, though others claim to have employed it about the same time. The specific action of arsenious acid on vital tissue is not well understood. It is supposed by some that it forms a compound with some element of the tissue, and in this way destroys the vitality.

Any such combination, however, has hitherto escaped detection; and it is certain that if a com-

pound is formed, it is not fixed or permanent in its character, since the arsenic will be carried to different parts of the system, and its specific influence manifested wherever it goes, which could not be the case if it formed a fixed compound. The more probable theory is that it destroys vitality by its influence on nerve tissue, producing such a change in its structure as to arrest its function at once. In reference to the action of this agent upon living tissue, much investigation remains to be made. Animal tissue takes it up by imbibition; and it is also absorbed by the circulation, and conveyed by it, as already suggested, throughout the system. Frequently, however, it is applied to living tissue, under conditions that prevent such absorption. It is often employed in the treatment of carcinoma. In the application of arsenious acid to the pulps of teeth, for their destruction, several circumstances are to be considered, such as the age of the patient, the constitutional tendency, the vascularity of the dentine. Where the vascularity is great, the utmost caution is required. The indiscriminate use of this agent in the teeth of the young is attended with great risk. Some constitutions are peculiarly susceptible to its influence, experiencing its effects even in remote parts of the system, after its application only to the pulp of a tooth. It is soluble in creosote and most of the essential oils,

and to some extent in alcohol and water. In many cases when it is applied to the pulp of a tooth, more or less disturbance of the periosteum is exhibited a short time after—in some instances in a few hours, and in others after several days, thus giving evidence that it has by some means come in contact with the periosteum. Its influence on this will often be manifested under percussion, in advance of any other symptom.

Application.—There are two or three methods of applying arsenious acid for the destruction of the pulps of teeth. The ordinary arsenic of commerce is used. It was formerly employed very extensively in connection with sulphate of morphia, mixed in equal parts, and applied to the pulp with a small pledget of cotton, moistened with creosote or some essential oil, the former being most frequently used. Alcohol, ether, or water may be employed instead of creosote, and in some respects and in some cases would be preferable. The pledget of cotton, thus prepared, is introduced into the decayed cavity, with the preparation in contact with the exposed pulp. Another pledget of cotton, saturated with a thick solution of gum sandarac and alcohol, or gutta-percha and chloroform, is placed over this in the cavity, to prevent the escape of the preparation, or the entrance of moisture or foreign substances. Any preparation may be used

that will accomplish these objects. In the application of the pledget, care must be exercised lest too much pressure be made on the pulp, and pain be thus produced. In order to prevent this pressure, another method has been adopted, which consists in forming a cap of lead, placing it in the arsenic, in the dry state or with some suitable solvent, and then fitting it over the exposed pulp, and retaining it there with a pledget of cotton, as above, or with Hill's stopping, gutta-percha, or adhesive wax. Thus the preparation comes gently in contact with the pulp, and prevents any pressure on it. The morphine is used for the purpose of diminishing the pain which frequently results from the application of arsenic only; but its influence for such a purpose is predicated more on theory than on practice; for facts prove that, applied to living tissue, it produces pain rather than allays it. Therefore the more observing and better class of practitioners have discarded it.

Other substances have been mixed with arsenic, for the purpose of mitigating or altogether relieving the deleterious consequences so liable to follow its administration; as, for instance, pulverized charcoal, which, combined with it in equal parts by weight, makes a favorite preparation with some practitioners, by whom it is claimed that the charcoal counteracts the specific effect of the arsenic on parts other than

those for which it is directly designed. But this theory, in the light of any elucidation yet given, is very vague. The claim cannot be that charcoal is an antidote to arsenic, since facts refute it; for if it were, the arsenic of the preparation, when applied to the pulp of a tooth, would fail of its effect, because the charcoal being also in contact with the pulp, would there, if ever, counteract the poison. But this it does not do, for the pulp is destroyed about as readily by this preparation as by arsenic alone. And if when the arsenic and charcoal are thus together no counteracting influence of the latter is manifest, much less will there be any when the arsenic, escaped from the charcoal, runs riot through the tissues, whither the latter cannot follow. The only probable advantage, then, of this preparation is, that the arsenic is not taken up from it by the tissues so rapidly as when it is applied alone, or with anything that is soluble with it; for when thus applied, the whole is very soon dissolved, and taken up by the pulp and dentine. But when combined with charcoal or the like, little more of the arsenic is absorbed than that which comes in contact with the pulp. Hence the conclusion that the influence of the charcoal is mechanical, and not therapeutic.

This preparation is better applied perfectly dry, beneath a lead cap, which should completely close

the cavity. Any other material that would mix as readily with the arsenic, without being soluble, and that would not induce irritation when in contact with the pulp, would be quite as good for this purpose as charcoal. Irritating gases generated in a tightly-closed cavity are absorbed by charcoal.

Cobalt, in which the active principle is arsenic, has been extensively used for destroying pulps; but it is in no respect superior, and in some respects it is probably inferior, to the preparation of charcoal and arsenic; it is applied in the same manner.

The length of time the preparation should remain in the tooth will be determined by the condition of the pulp when it is applied, the age of the patient, the vascularity of the dentine, the susceptibility of the patient to the influence of arsenic, and like circumstances. It will usually be from three to twenty-four hours. In some cases a very small particle will thoroughly accomplish the work, while in others a much larger quantity may remain in contact with the pulp even for a much longer time, without producing more than a superficial result. And cases occasionally occur in which it seems almost impossible to destroy the vitality of a pulp with arsenic. A case is on record in which the pulp was first fairly exposed in a superior bicuspid tooth, the health and constitution being good, and the temperament sanguino-lym-

phatic; and arsenic with morphine was applied to it, directly, five times within ten days, without producing any apparent effect; then an application of creosote and tannin was made three or four times, during as many days; afterward the tooth was temporarily filled with gutta-percha; and finally, in ten or twelve days, this filling being removed, the pulp appeared in a perfect state of preservation and health, with all the indications of undiminished vitality. Over the exposed point there was placed a non-conductor, and upon it a filling of gold, and one year after, the tooth presented the appearance of perfect life and health, having given the patient no annoyance during the whole period.

Hence, it is quite obvious that there is a great diversity of susceptibility to the influence of arsenic, and that the study of these idiosyncrasies is both interesting and valuable. The occurrence of injurious consequences from the use of arsenic has induced many operators to abandon it altogether. But these injurious results perhaps occur always either through mal-administration or from a peculiar susceptibility to the influence of the drug, and a superior skill and a more accurate diagnosis would avoid them almost entirely. After the desired result with arsenic has been obtained, it has been thought that antidotes to arrest its further operation might be made available.

The hydrated sesquioxyd of iron is one of the best antidotes to arsenic, and has been used in the teeth to counteract its injurious effects; but it is of no avail here; the arsenic has the start of it, and, indeed, would outstrip it, with an equal start.

From the foregoing in regard to arsenic as an application for destroying the pulps of teeth, the following conclusions are justly deducible: it is, in general, very efficient; it is a heroic agent; it should in all cases be used with great caution; in some cases it is entirely inadmissible; a free administration of it is liable to be followed by bad consequences; and skill and care, rather than counteracting agents, are to be relied upon in its application.

Filling Pulp-Cavities and Canals.—After the pulp of a tooth has been destroyed, whether by an operation or by therapeutic treatment, the part at the point of its detachment should in most cases, before the filling is introduced, be rendered healthy; if possible, a permanent cicatrice should be formed. In cases, however, of good constitution and strong recuperative power, where a pulp has been removed by an operation, the root may be filled as soon as the hemorrhage has ceased; but such cases rarely occur. Generally the part will require treatment; and the character and duration of this will be determined by circumstances—as, the vital energy of the system,

and the method employed for the pulp's destruction. When this has been effected by an operation, the wound produced by an excision is restored to soundness much more readily than when by an application of arsenious acid, and less topical treatment will ordinarily be required; indeed, in many such cases there will be nothing else required than to keep the canal well cleansed, so as to obviate any irritation that otherwise might be induced by decomposition. When the pulp has been destroyed by arsenious acid, more energetic treatment is usually demanded; for then there is always a greater or less disposition to slough or discharge through the tooth, which must of course be entirely abated before the operation of filling is at all admissible. In the treatment of this condition, the canal should be kept perfectly clean by frequent syringing; floss silk, moistened with creosote and tannin, should be introduced to the extreme part of the cavity or canal, and should be changed every twenty-four hours, the cavity being thoroughly washed each time. It will be necessary in many cases to continue this treatment for several days. In order to determine whether the condition is such as to admit of the filling, the floss silk should be removed after a sufficient time is supposed to have elapsed, the cavity thoroughly cleansed and dried, and a portion of dry floss silk or cotton introduced loosely into the canal.

Then close up the decayed cavity with adhesive wax, gutta-percha, or some other substance that will effectually exclude the moisture; let it remain thus from twelve to twenty-four hours; then open the cavity and withdraw the silk or cotton, and if this is found free from moisture or odor, the tooth is ready to be filled.

The treatment just described will be sufficient for all cases in which the pulp has been destroyed by the operator. But teeth whose pulps are already dead would seem to be less difficult of treatment and filling; yet such is not the case; indeed, the therapeutic treatment of these is usually more protracted, and their diseased condition less easily controlled; and this because of the fact that the decaying pulp remaining in the canal becomes very offensive and irritating to the living parts adjacent, in which it induces a chronic diseased condition, frequently involving the dentine along the walls of the canal in decomposition.

A classification of these teeth, based on their conditions, might be somewhat auxiliary to a further examination of this subject; and the following will probably embrace them all:—

1st. Those whose pulps are dead, but their attachment and adjacent parts alive and healthy.

2d. Those predisposed to disease.

3d. Those already diseased, either discharging acrid matter through the root, or exhibiting inflammation of the periosteum.

4th. Those having alveolar abscess.

Sound or slightly decayed teeth are sometimes found with dead pulps. This condition may be produced in various ways: by blows, or by any force that will partially loosen the tooth; by undue pressure in filling; by excessive sensitiveness of the dentine, even where the decay is not extensive; and, sometimes, by a filling of the tooth when it is in an unfit state for the operation. Ordinarily, in cases in which the pulp is dead before its exposure, and there is no abscess from the root or periosteum, the pulp-chamber may be opened and the remains of the pulp removed. The canal should then be cleansed out, and floss silk, moistened with creosote, introduced and permitted to remain from one to six hours, when it should be withdrawn, the pulp cavity and the canal again thoroughly cleansed, when, if there is no discharge of pus through the root, it may be filled. The fact that the dead pulp is inclosed in its chamber without producing irritation is evidence that there is no secretion of pus. Occasionally, where the pulp has died from exposure, the living part immediately adjacent will present a healthy condition, and there will be no discharge; such cases should be treated in

the manner just described. In operating on teeth already dead, more delicate manipulation is requisite to prevent irritation than on those in which the pulp is destroyed by the operator. In very many cases of dead teeth, where there is not a state of actual disease, there is a strong predisposition to it; and in these cases the preparation of a cavity, or the introducing and condensing of a filling, may produce inflammation of the periosteum. When such a conditon is recognized, several sittings may be required to complete the operation. It is not always easy to recognize such a predisposition; yet whenever it is suspected, it is well to press the investigation, which may be guided by the following rules. Ascertain whether the tooth experiences a different sensation or any pain under percussion in any direction; whether periostisis has ever existed in that or in a contiguous tooth; whether the parts adjacent to the tooth are in a healthy state; whether there is a general inflammatory diathesis or an enfeebled condition. These are the prominent points in an examination of this kind.

Where this predisposition exists, it may be counteracted by general or local treatment, according as it depends on general or local causes; but in every case, this treatment should be very carefully conducted, and it will in some instances have to be protracted. In those cases where there is a discharge

through the root of the tooth, such treatment should be adopted as will most speedily and effectually suppress it; and if it proceeds from a remaining portion of the pulp-tissue near the point of the root, this should be removed, and such application made as will prevent a recurrence of the discharge, and assist the part to recover its health. The discharging surface may be broken up by cutting it away with an instrument, or be destroyed with an escharotic—either nitrate of silver, creosote, or chloride of zinc, in the use of which, several applications will in many cases be necessary. From their action, the secreting surface is destroyed, healthy granulations spring up, and a healthy condition is established.

The discharge should be wholly suppressed before the tooth is filled, otherwise, alveolar abscess would probably occur. In cases where there is periostitis, it must be subdued before the tooth will tolerate the operation of filling. To attain this end, the treatment required will be dictated by the nature of the causes which operate to induce the disease.

The periostitis of teeth whose pulps are dead commonly has its origin at the point of the root, from irritation induced in the beginning by the dead and decomposing pulp and other matter at that point. In many instances the inflammation is not confined to the root of the tooth on which it began, but it will

extend to the alveolus, the gums, and the periosteum of the neighboring teeth. Whenever the existence of this disease is suspected, and yet not very apparent, as is often the case, the examination should be very thorough. In some instances, percussion of the tooth at one particular point, and at a certain angle, will produce pain; whereas, striking on any other part of the tooth, or at any other angle, will cause none at all. By an exercise of care and discrimination, the exact point of disease, even if confined to a small space, may be ascertained. For instance, if striking on the labial surface of a central incisor, near the point, produces pain in the socket, while on any other point it does not, the place of the inflammation is the anterior portion of the root, at or near its point. By such means the skillful and discerning will be enabled to form a tolerably accurate opinion as to the extent and location of periostitis in all cases; and this is an important consideration, for if inflammation is found confined to a small portion of a root, the treatment, if local, should be as near that point as possible.

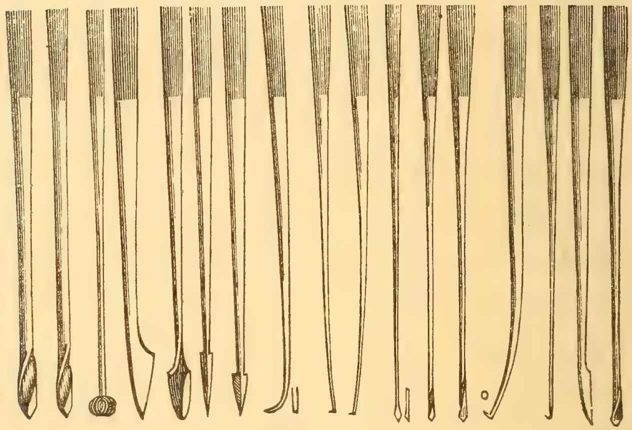
Inflammation of the periosteum may sometimes be induced by the presence of foreign substances forced down between the free margin of the gum and the neck of the tooth, which have remained there till they have become vitiated, so as injuriously to affect

the gums and periosteum. A deposit of salivary calculus sometimes produces inflammation of the gums and periosteum. Teeth otherwise healthy are in some instances thus affected, though those which have lost their internal vitality are much more liable to such disease.

Preparing the Teeth and Roots for Filling.—After the tooth has been brought to a healthy condition, the decayed cavity is first to be excavated and made of proper form, the pulp-chamber to be shaped, and then the canals and the roots to be prepared for filling. For the preparation of decayed cavities here, the directions hitherto given on that subject will be quite sufficient. In the formation of the pulp-chamber, the abrupt projecting portions of dentine should be cut down; and if there is any decomposition of this, it should be removed. The pulp-chamber may be, when it is excavated, of a general retaining form, or there may be retaining-points made within it at proper situations. In the preparation of the canal in the roots, some operators do nothing more than cleanse them thoroughly. Another method is to pass fine bur-drills into them as far as practicable, thus making the opening of the same size all the way, or to scrape out the canal with a fine No. 10 excavator. Very fine, delicate instruments are required for cleansing out and forming the canals; and they

should be quite elastic and of low temper. A set of instruments for forming the canals in the roots of the teeth have been devised and made by Dr. C. Palmer. These are of such forms and sizes as to be suitable for every case. They are represented in Fig. 90.

Fig. 90.



Before the introduction of these instruments, the method of forming these canals was by the use of a three or four-sided broach, tapering to a sharp point, and in inclination corresponding as far as possible to that of the canal. This instrument is employed to enlarge the canal, and give it a regular shape; a variety should be at hand, so that one of the proper size and taper can be selected. In cleansing and forming the canal, care is necessary to prevent the instrument from passing entirely through the point

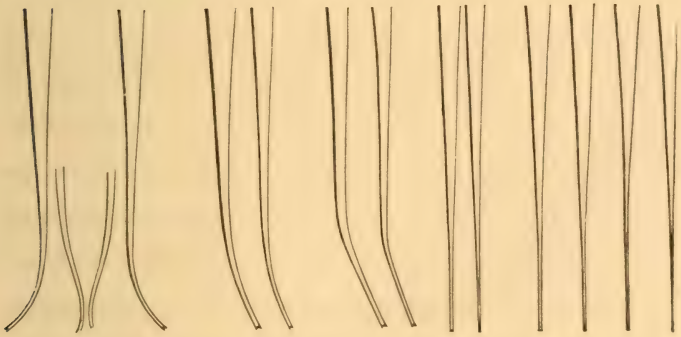
of the root. Such an accident is not very liable to occur with the tapered broach; but with the miniature excavator, or barbed wire, it is, especially in the teeth of the young, where the foramina through the roots are large; and it is especially liable to happen to the incisors, the canines, and the palatine roots of the superior molars. But after the complete development of the teeth, there is no excuse for an accident of this kind, for then there is an abrupt contraction of the canal near the point of the root, which may always be detected by a careful introduction of the instrument.

The decayed and pulp-cavities and the canal all being thus prepared, are now ready to receive the filling. For filling the root, there are several methods, one of which is, to prepare small strips of gold, of two or four thicknesses of foil; take these on the point of an instrument, and pack them into the root, in successive folds, till the canal is full. Another method is, to take small portions of gold, and pack them in, one on another, till the canal is full. Another is, to take strips of from two to four thicknesses, and from one to two lines wide, and roll them on a fine broach in such a manner as to make a cone-shaped block, a little longer than the depth of the canal to be filled, and of the same taper; quite a number of these blocks will be required for any

given case, of various sizes, lengths, and densities. The longest, largest, and least dense should be first used, the last requiring to be of less size and greater density. These cones may be made as dense as desirable by rolling them firmly between the thumb and fingers, after having taken them off the broach. They are then introduced with the plugging pliers, and passed up as near to the point of the root as is consistent with safety. In some instances there is danger of thrusting them through the point; and in order to prevent this, the end of the first block introduced may be made so large that it will not pass through, even when forced up; or, what is probably better, a very small round pellet of gold may be forced up the canal, as near to the point of the root as admissible, and this serves as a foundation for the subsequent portions of gold, and prevents them from passing too far up. The cone-shaped blocks may be introduced and consolidated with an instrument of the same general form as the canal, but much smaller. This kind of instrument should be made of untempered steel, though some operators make them of whalebone, to prevent breaking off in the canal,—an unnecessary precaution, since no skillful operator would ever break off a low-tempered, well-polished, properly-formed steel instrument of this kind. After a block is placed in the cavity, the

instrument is thrust in by its side, consolidating the gold to the side of the cavity. Thus the blocks are successively introduced and consolidated, till the canal is filled. It is better so to arrange as to introduce the last portion of the gold near the centre of the canal, rather than at the side. The last blocks introduced should be stiff and dense, that they may be thrust in with considerable force. The method of filling canals at present employed by many, is in the use of the filling instruments invented by Dr. C. Palmer, represented in Fig. 91. There is a variety

Fig. 91.



in size and somewhat in form, so that in all positions they will readily enter the canals and effectually consolidate the gold, which is introduced in small cone-shaped pellets, loosely rolled, so that they may be thoroughly condensed.

Another method of preparing gold for filling roots,

is to take the pure metal, and roll it down on a good rolling-mill as thin as possible, keeping it well annealed; of this form the cones, and introduce them as already directed. Made in this way, they are stiffer, and fill up much more rapidly than when made of foil. They are to be condensed in the same manner. Where the canal has been formed with a tapered broach, it may be filled with a gold wire, made of the same size and taper of the broach; this wire may be cut off at the orifice of the canal, or left protruding more or less into the decayed cavity, and be covered up with the filling. When a lost portion of the form of a tooth is to be restored, such projecting wires may be made very valuable as anchorages.

Some other substances have been thought quite as suitable for filling the roots of teeth as gold. Lead has been employed for this purpose; but the principal difficulty with this is, to get it into such a condition as to be used with facility; but, if as completely introduced, it would probably answer the purpose quite as well as gold. Dr. F. Peabody, about three years ago, described a method of filling the roots of teeth with lead, which his experience, as well as that of some others, seems to indicate, in many cases at least is very good. It consists simply in forming the canal in the root, slightly tapering from the pulp-chamber to its termination; then form from a lead

rod a cylinder or cone of the same size and taper as the canal in the root; let this be driven firmly to its place in the root; the rod may now be cut off, leaving a slight projection from the entrance to the canal; by this the orifice can be very perfectly closed; then the pulp-chamber and cavity of decay may be filled in the usual manner. Tin foil is also used, and, under favorable circumstances, with success. Gutta-percha, dissolved in chloroform, is used to some extent, and, it is claimed, with decidedly good results. It is prepared of such consistence as to be readily pumped into even the smallest canals by a little piston made by wrapping cotton upon a fine broach; and, after having the canal prepared, it is filled by forcing the gutta-percha solution in with the appliance referred to. Some experiments, too, have been made with plaster of Paris and similar substances, for filling roots and pulp-cavities, but with rather uncertain success—some claiming instances of success, and others reporting, in every instance, failure; so that there are not sufficient data to warrant the adoption of plaster or any similar substance in practice.

In cases in which there is liability to irritation, the operation of filling a root is quite enough for one sitting; and in any case, not more than three roots should be filled at one time. The filling of a large pulp-cavity will occupy one sitting, and that of the

decayed cavity another. When a respite is thus had between the filling of the pulp-cavity and that of the decayed cavity, the former should be filled with Hill's stopping or gutta-percha, so that no moisture may penetrate it; and then when the latter part of the filling is to be introduced, it will proceed as though there had been no interruption. From one to four days should intervene between the different divisions of the operation. The filling of the decayed cavity is to be performed according to the directions already given. When inflammation ensues after an operation of this kind, recourse is had to the treatment already described for preventing, counteracting, or reducing inflammation.

Some experiments have been made to test the effect of restoring the parts to health, forming a cicatrice at the point of the root, cleansing this out, filling the pulp-cavity and the cavity of decay, and leaving the canal unfilled; and it is maintained that this method will, in favorable cases, answer the purpose quite as well as that of filling the root, and incur less risk. The treatment will be such as already described for the restoration of diseased roots; all discharge through it must be suppressed, and all foreign substances liable to decomposition removed from the canal, so that there may be a complete restoration before it is closed.

Oftentimes, when a tooth has been filled without filling the roots and pulp-chamber, if the pulp be dead, or if the pulp afterward dies, the chamber becomes the receptacle of a very vitiated and acrid material, the retention of which will almost invariably produce irritation. In all such cases, an opening should be made for the escape of the offensive matter. This is done, if the filling is not to be removed, by passing a small drill into the pulp-chamber or canal, just above the filling, as close as possible. The handle of the drill should be depressed, so as to give the opening a downward inclination from within outward, and thus favor the escape of any secretion.

In the superior molars, this opening may be made through the masticatory surface; it may sometimes be in the depressions on the crown surface, even though there be no filling. In incisors, it is made through the palatine portion of the crown. It is better, however, in all cases, to make an opening of this kind through the neck of the tooth, just under the free margin of the gum, since here foreign substances are not so liable to be crowded into it as where it is through the masticatory surface. In cases in which it is obvious at the time of filling the tooth that such an opening will be required, it is better to make it before the filling is introduced, as follows: first, prepare the decayed and pulp-cavities

for filling; then drill through the neck of the tooth into the canal, to the extreme part of the pulp-chamber; and finally introduce into this hole, its entire depth, a piece of smooth steel wire, such as will closely fit, leaving it exposed through the decayed cavity—and if it is not enough exposed when introduced, the tooth-bone may be cut away about it, till it is fully exposed, when the decayed and pulp-cavities are filled in the usual manner, and condensed solidly against the wire. After the filing is finished, the wire is withdrawn, leaving a smooth, continuous opening for the escape of any secretion that may collect within. When the opening into the canal is not made till after the tooth is filled, there is liable to be a space between it and the filling that will receive and retain fetid matter, which may become very offensive. This method of treatment is, however, always to be deprecated, and should never be employed except as a last resort, or in cases where it is impossible to command the time and opportunity for the proper treatment; and even then it is better to make the opening and entrance into the chamber and canal just as though it were to receive immediate treatment; for in a great many instances the opportunity for that may soon occur.

DENTAL PERIOSTITIS.

This affection of the investing membrane of the roots of the teeth is of frequent occurrence after the death of the pulp, but rarely if ever before. Inflammation of this tissue, in its manifestation, is modified by the anatomical structure of the parts.

Whether there be two membranes in the alveolar sockets, the one lining the walls of these, and the other investing the roots of the teeth, is not a matter of importance so far as the nature and treatment of this affection is concerned. This condition of the dental periosteum is induced by such irritating causes as would produce inflammation in other tissues.

The first indication of approaching difficulty in this tissue is a sense of slight fullness, which invites contact, and even pressure from the opposing teeth—such pressure affording a rather pleasurable sensation and seeming relief.

This condition is brought about by determination of blood to the part, and the surroundings being such as to prevent free expansion to the capillaries, and other small vessels ramifying this membrane, these walls are pressed upon in proportion to the force of this determination.

This effort at expansion will occasion, especially in those teeth having very conical roots, quite a per-

ceptible elongation, and this more particularly occurs when active inflammation supervenes, which is the sequence of the state of irritation to which reference has just been made.

After active inflammation has occurred, pressure or percussion upon the affected tooth usually causes great pain,—to such an extent that sometimes the slightest contact even by the tongue is intolerable.

This condition varies much in degree in different cases, dependent largely upon the predisposition and susceptibility to exciting causes of irritation and inflammation, together with the character of these exciting causes, whether concentrated in action to a mere point, or more extensive in their sphere of operation.

Oftentimes only a very small portion of the periosteum of a tooth will be affected; it may be confined to the immediate vicinity of the point of the root, or to one side, or to the periosteum near the margin of the alveolus and the border of the gum.

Indeed, so circumscribed is this affection often found, that the periosteum on one side of a root will pass through all the successive stages of inflammation to suppuration and destruction, without that upon the opposite side having undergone anything more than a slight irritation, if even that. In such cases the vitality has sufficient power to hold the

disease at bay, and confine it to the immediate point of attack.

When there is a systemic predisposition, the local exciting causes will sooner and more vigorously attack. Always when the pulp of a tooth is devitalized, the periosteum is more liable to disease, and perhaps for several reasons. In almost all cases there are irritants at hand that did not exist before; and the periosteum is either enfeebled, and consequently less resistant, or the demand upon its function greater than before, in view of its being the medium of connection between the normally vital tissue and that which is devitalized, or, at best, its life very much impaired; and when the latter condition exists, the nourishment received by the cementum and dentine is wholly through the periosteum. In these facts doubtless are to be found the cause of the greater susceptibility of the dental periosteum to disease after than before the death of the pulp.

The exciting causes of this affection are to be found in the acrid debris of the dead and decaying pulps of the teeth, passing either in a fluid or gaseous state through the foramen at the point of the root, and there coming in contact with the periosteum, and in various deposits, calcareous and others, insinuated beneath the margin of the gum, encroaching upon and irritating the periosteum.

It is also sometimes occasioned by an extension of disease from some other point. As an illustration of this, in susceptible cases, the periosteum of one tooth may become affected by the action of some local irritant, and two or more of its neighbors become affected by extension of the inflammation.

Some medicinal agents act specifically upon the dental periosteum, inducing a very painful condition, thickening of the tissue, and elongation of the teeth.

Mercurials present an illustration of this class of agents. The precise condition produced in the dental periosteum in mercurial ptyalism is perhaps not clearly comprehended. It is more than simple inflammation. It is not modified or controlled by the same remedial treatment. It attacks the periosteum of living teeth as readily, and with quite as much violence, as of those which are devitalized. Alveolar abscess is not a common result of this affection of the periosteum.

Treatment.—The treatment of dental periostitis, in its details, will be governed by the attendant conditions, such as systemic predispositions, the vital force, and the local causes, and their peculiarities.

Systemic treatment should have for its object the removal or counteracting of predispositions, and the abatement of the determination of blood to the part in question, by inviting it to other parts, by their

stimulation, and by introducing into the system such agents as will tend to allay excitement in the affected part, and induce, so far as possible, an equilibrium of circulation throughout the system.

The local treatment must also be wisely and faithfully attended to. The principle applicable to the treatment of inflammation in any tissue is that to be employed here. It will be remembered, however, that there are many medicinal agents which possess very desirable properties that are still totally inefficient, because of a want of adaptation. We have, however, at our command some very efficient remedial agents for the treatment of this affection, and the list is being constantly enlarged.

We propose here to consider rather the principles involved in the treatment than details for special cases.

The causes producing and influencing the disease should always be fully apprehended, immediately after which the following points should receive attention: First, remove all irritants; this will embrace the removal of the dead pulp, and all the debris from its chamber, and from the canal in the root or roots, and rendering them perfectly free from all offensive material, and keeping them so; and the removal of all deposits that may be upon the teeth, especially those that may encroach upon the gum, or the alve-

olus and periosteum at or beyond the neck of the tooth; also the removal of all injurious and useless teeth and roots in the vicinity.

Secondly, relieve the congestion of the affected part, in some or all of the following ways: either by systemic influence, as already suggested, or by counter-irritation, producing determination to a neighboring part, and thus relieving the affected part, or by depletion from the gum immediately opposite the seat of the affection.

Counter-irritation may be effected by scarifying the gum, or by the application of some irritating agent, such as tincture of capsicum, tincture of iodine and cantharides. An excellent preparation of the latter, denominated cantharidal collodion, is very effective. This preparation when applied to the gum acts promptly and efficiently in almost every case of acute dental periostitis; it produces desquamation upon the surface of the mucous membrane where it is applied.

Counter-irritation may be produced, also, by making a deep incision in the gum opposite the tooth affected, and introducing a little flock of floss or cotton, saturated with creosote, which is to be kept in place till the inflammation of the periosteum is allayed, which will be effected in from one to five days. The silk or cotton should be changed every

day till the restoration of the tooth to health is effected, when it is to be removed, and the wound permitted to heal. Mild stimulating applications to the gums in the immediate vicinity, to increase the circulation, will in some cases be quite sufficient. A vapor bath, or warm water applied to the part, is often beneficial; and in some cases a continued application of cold, by means of ice-water, will arrest inflammation of the periosteum.

The tincture of aconite-root is a valuable local application. It is a powerful sedative and antiphlogistic remedy. This, with equal parts of tincture of opium and chloroform, constitutes a very valuable local remedy for periostitis. It may be applied by occasionally moistening the gum with it, or by placing on the gum, opposite the seat of the affection, a small pad of bibulous paper or lint, moistened with the preparation, which may remain from three to five minutes. This may be repeated as occasion may require; usually, however, from one to three applications will be sufficient.

Depletion with many is a favorite method of treatment, and is often productive of very good results. Two or three methods of accomplishing this are employed. Simple scarification of the gum, cutting it more or less deeply, will secure sufficient hemorrhage, especially if the gums are quite vascular;

when this fails, cupping, or the artificial leech, may be employed; but the natural leech is the most efficient means of local depletion in this treatment; and every dentist should always have these at command, and be familiar with their use. The application of a leech, in very many cases, will in a short time subdue the most violent attack of acute periostitis.

In the treatment of this affection, hypodermic injections give promise of most desirable results; for this purpose the solution of morphine or tincture of opium, from ten to twenty drops, may be injected, with a proper syringe, beneath the mucous membrane, when the pain will be found to subside in a few moments, and the severest symptoms be abated in a few hours.

In all cases of periostitis, the sooner it can be brought under proper treatment after the attack, the more easily will it be subdued. In cases of longer standing, where the affection has assumed a chronic form, the membrane more or less thickened and indurated, and a persistent soreness of the tooth affected, heroic and persevering treatment will be required to overcome the difficulty; in the great majority of cases, however, the result is the formation of alveolar abscess, rather than the condition just referred to, a description and treatment of which will next receive consideration.

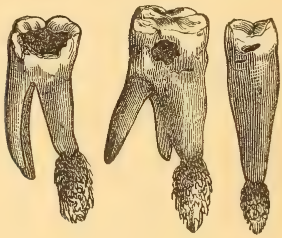
ALVEOLAR ABSCESS.

When inflammation occurs in the periosteum to the extent that the structural character of the tissue can no longer be maintained, then disintegration begins in it, and the surrounding tissue also, so far as it may be involved. When the condition arrives in which the life action ceases, the tissue at once begins to undergo solution, and in addition to this, the pabulum or nutrient material, brought into the diseased territory, is for the most part vitiated, its nutrient quality destroyed, and it is converted into debris, except that from it, under favorable circumstances, coagulated lymph is formed, which constitutes what has been so generally denominated the sac, and by some the pus-secreting sac, and by others the pyogenic membrane.

Now, strictly, it is not any of these, but is simply a mass of coagulated lymph, varying in quantity, when it exists at all, from a little shred or bleb, that is but little more than visible, to a mass as large as the tooth to which it is attached. As to its location, it varies; sometimes it is embraced by and fills up the space between the roots of the molars, either superior or inferior. In some cases it is merely an irregular mass attached to the end of the root about which the disease is; in other cases it will cover a

large part of the surface of the root or roots involved. The accompanying illustration (Fig. 92) represents

Fig. 92.



the position of the lymph mass on the roots of different teeth. It will be more or less firmly attached according to the extent of the disintegration of the periosteum—being less adherent when there is the greater destruction of the tissue. A portion will sometimes, upon the removal of the tooth, remain in the socket, with some attachment, though usually but slight, to the walls; this, however, is not its usual place of lodgment and attachment. The density of this lymph mass varies in different cases. Sometimes it is quite dense, firm and resistant; at other times so soft and flabby as hardly to support its own weight. Now, that this substance is instrumental in, or has anything to do with, secreting or forming pus, or the material discharged from an alveolar abscess, is not established nor warranted by deduction nor by fact.

Now, the question occurs, what is the object of this product? It may, in the first place, be regarded as an abortive effort for the repair of lost tissue, and, in the second place, the encystment of the disease-producing agent. Neither of these, however, can be accomplished. Repair cannot take place so long as the disease-producing agent is present; and the character of the agent or agents, and the anatomical structure of the parts, preclude encystment. The local agents that occasion alveolar abscess may be in form either solid, soft-solid, fluid, vapor or gas. Some of these could not be encysted in any anatomical structure, and none of them can be in the tooth socket. This lymph mass is not only of no service in respect to reparation, but is a real obstacle to the proper accomplishment of that process. This is fully recognized in all the proposed plans of remedy; its removal is always regarded as an important factor in the treatment.

The character of the discharge from alveolar abscess differs greatly in different cases, and somewhat at different periods of the same case. It sometimes consists of pure or laudable pus; this is of a yellowish-white color, opaque, inodorous, sweetish taste, and of a creamy consistence. In the majority of cases it varies from this, however, exhibiting less the character of pus, with diminution of pus-corpuscles,

and an increase of vitiated ichorous fluid, in which sometimes pus-corpuscles are not found at all, with an acridity so great as to excoriate living tissue whenever it comes in contact with it.

Usually, when pure pus is secreted, coagulated lymph will be found most abundant; and, on the other hand, when a highly-vitiated, acrid discharge is found, there will be almost, if not an entire absence of the lymph mass.

The character of the discharge is modified by the systemic condition, by the tissue disintegrated, and by the character of the local irritants; and it can only be changed by a modification of the first of these, and the removal of the latter.

The size of the abscess cavity varies in different cases; in some it is quite small, involving a very little territory in the immediate vicinity of the point of irritation; in others it becomes enlarged, sometimes to twice the size of the tooth about which it is. This difference arises from the varying severity of the disease, and the peculiar susceptibility of the parts.

Usually the cavity has attained its full size before the evacuation of the pus; and if this is benign, little or no disintegration takes place afterward; but it may be otherwise if the secretion is acrid.

In an abscess rapidly formed, there is very con-

siderable pressure by the contents upon the walls of the cavity while it is closed, and this is always the cause of pain, which in many instances is very severe. So soon as an opening is effected, and the tension relieved, the pain in a great measure ceases.

There are various directions through which openings are made for the escape of the pus. Sometimes the discharge is through the root, sometimes from between the tooth and alveolus, and at other times directly through the alveolus and gum. There are occasional cases in which the discharge will be at a very considerable distance from the point of secretion; but in such cases it always follows some natural avenue that affords a facility for its passage, as, for instance, along a suture. There are cases recorded where the issue from an abscess of the central incisor was near the posterior portion of the hard palate, and in these the channel of the pus lay along the suture of the palate bones. Sometimes the opening from an abscess of the first or second molar will be opposite the bicuspids on the buccal portion of the gum. Alveolar abscess is exceedingly variable in character, according to the constitutional peculiarities and susceptibilities of the patient, the condition of the parts immediately adjacent, and, to some extent, the cause which has produced it. In a good constitution, after an abscess is formed, it will discharge healthy pus. Occasion-

ally, yet very seldom, does nature alone effect a permanent cure. In constitutions of a cachectic diathesis, alveolar abscess is liable to constant discharge of an unhealthy pus, or purulent acrid matter, and the parts about it are usually in a diseased condition.

The cases in which alveolar abscess is most likely to occur are those of a manifest inflammatory diathesis, or those in which there is considerable local inflammation, from some local exciting cause. In the cases of constitutional predisposition, the abscess after a time assumes a chronic character, constantly secreting and discharging pus, but does not usually cause much pain, though the tooth from which it proceeds will experience some soreness and an uneasy sensation. In the acute forms of it, however, there will be intense pain. In some cases an abscess will be formed without much irritation of the surrounding parts, while in others, irritation and inflammation will extend to parts more remote, especially if there are active irritating agents at work.

Treatment.—The treatment of alveolar abscess will be governed by the constitution of the patient and the condition of the part affected; a case of recent origin will yield much more readily than one of long standing. When a case has assumed the chronic form, and the surrounding parts have become implicated in the diseased condition, a restoration to

health is often very difficult. In the earlier periods of the profession, the removal of alveolar abscess was thought to be, as a general thing, wholly impracticable. But by the treatment now employed, this affection is readily eradicated, unless the parts in the immediate vicinity are very much involved. In some cases the accumulation on the point of the root is very large, and absorption has taken place, to accommodate it; in such instances, this being destroyed, the space occupied by it will be filled up with a healthy tissue. In young persons, when an abscess is formed on the point of a root, especially in the single-root teeth of the superior maxilla, the discharge is frequently through the tooth, in consequence of the large size of the foramen at the point of the root; and generally, in such cases, the local treatment may be made through the canal. Sometimes the discharge is between the root and the wall of the alveolus. More often, however, especially in persons after complete development, the discharge is through the alveolus and the soft parts to the surface, by the shortest course.

When an alveolar abscess is influenced by any constitutional derangement, general treatment must be resorted to, such as the condition indicates. The local treatment always demanded is such as will break up and destroy the accumulated lymph mass.

This is effected either by surgical or therapeutic treatment, and frequently, in chronic cases, by both together, but in the great majority of acute cases therapeutic treatment alone will be sufficient. In order to break up an abscess by an operation, it must be easy of access; and it is very seldom that an operation of this kind can be performed through the root of a tooth; but, fortunately, in almost all those cases where the discharge is through the root, therapeutic treatment alone will answer the purpose. When the point of discharge is on the gum opposite the accumulation on the root, a sharp-pointed bistoury should be used, and the cannl of discharge sufficiently opened to admit the free use of the instrument at the seat of the disease. Then the lymph mass should be dissected from the point of the root, and removed as completely as possible. After this, if the case is a favorable one, nature may be left to accomplish the work, in which case the detached material will be thrown off, healthy granulations developed, and the parts restored to complete health. In other cases, however, after an operation, nature unaided will not complete the cure; but such therapeutic treatment must be resorted to as the circumstances seem to require. In some cases the opening through the alveolus will require to be enlarged; and this part of the operation requires great care. All loose

particles of bone should be removed from the opening, since, if permitted to remain, they would produce irritation, and tend to increase the difficulty.

When the therapeutic treatment is applied through the root, the canal is to be cleansed of all foreign and detached matter, and opened freely through to the point; and if the discharge is very fetid, some disinfectant should be used, than which perhaps nothing is better than diluted creosote, since a fetid condition keeps up irritation. The cleansing of the root may be accomplished by injection of chloride of sodium; after which the agent to act on the disease at its seat is to be introduced. There are a number of agents used for this purpose, the chief of which are salicylic acid, chloride of zinc, nitrate of silver, and creosote, the first two being applied in the solid and the latter two in the liquid state—though the nitrate may be employed in the solid form. (Use of salicylic acid, see Appendix E.) The method of using the chloride of zinc is to pass it in small portions up the canal, on a piece of silk, with a fine probe, entirely through the point of the root, which process should be repeated every twenty-four to forty-eight hours, as the case may indicate. After this, during two or three days, floss silk, moistened with a mild solution of creosote and tannin, in alcohol, should be applied daily; and then clean silk or cotton may be worn in the canal,

changed every day, for three or four days, or till it is manifest that there is no longer any discharge, and that the parts are in a healthy condition. If nitrate of silver, in solution, or creosote, is used, a piece of floss silk should be moistened with it, and passed through the root in the manner already described. The nitrate is more prompt of action than creosote, and will accomplish a specific object in a shorter time. Either of these solutions may, by the use of the syringe, be very effectively thrown through a root in the following manner: Fill the orifice of the canal with gutta-percha; drill through it a hole large enough to receive tightly the point of the syringe; and then, charging with the solution, inject it through the root; in cases where there is an opening through the gum, the injection may be forced round through this. The condition of the parts will indicate how long this kind of treatment should continue. Ordinarily, when the discharge is entirely through the gum, the bistoury should be used to enlarge the opening; or in some cases it is preferable to use the "sea-tangle" tent; for this purpose form a plug of this material, in size to fit closely into the fistulous opening, where it should be placed and remain for twenty-four to forty-eight hours. When saturated with moisture, the tent expands to more than double its size when in the dry state. Care

should be exercised lest too much irritation should be produced by the pressure; this, however, can be easily regulated. In many cases therapeutic treatment alone will accomplish the object; and when the opening is large and direct, the therapeutic agents may be introduced through it directly to the seat of disease. If nitrate of silver, in solution, or creosote, is used, it should be introduced to the point of affection on a pledget of cotton or floss silk, as heretofore directed; or if, as is preferable, chloride of zinc or nitrate of silver in solid, it should be passed through the opening into the main cavity. This treatment should be kept up till the indications are fulfilled.

In the treatment of abscess of the inferior maxilla, much difficulty is often experienced from a want of free egress for the secretion. While, in the superior teeth, the pus may frequently escape through the tooth by gravitation, this force in the inferior jaw increases the difficulty. The secretion being made at the bottom of the socket, it remains there, and is frequently pent up till it finds an outlet through the gum, somewhere between the point of the root and the neck of the tooth. It is in many instances very difficult to get an opening as low down as the point of the root, since the buccal attachment to the gum is usually quite above that point, particularly in the

case of the molars and bicuspids. Very seldom, if ever, can the coagulated lymph on the root of an inferior tooth be destroyed by treatment applied through the canal of the root. Some are accustomed to make a vertical incision of the gum, as low as the point of the root, and perforate the alveolus, and treat through this channel, as already described. Owing to the disadvantage above mentioned, much more energetic treatment is necessary to attain success with an abscess of the inferior than with that of the superior teeth.

In the great majority of cases, where one-half or more of the periosteum of a root is involved in abscess, the indications are generally supposed to point to the removal of the tooth. In the lower teeth, a very serious difficulty occasionally occurs from abscess, namely, an external opening and discharge; and in all cases where this condition has already been reached, the offending tooth should be removed. But when such a result is only anticipated, and is yet contingent, treatment may be employed to avert it; and in order to do this, a deep and free incision should be made in the gum, opposite the affected tooth, and poultices applied within; and where there is external swelling, pressure is recommended, as follows: Adjust a piece of thick sheet-lead to the part, and make the pressure on this

by means of a bandage comprising it and passing round the head. It is supposed that this application counteracts the gravitation of the secretion, pressing it upward, and thus inducing it to seek an outlet at some more desirable point.

In many cases the most prompt and efficient treatment consists in the extraction of the tooth involved by the abscess. This should be carefully done, that there may be no fracture of the alveolus, and no laceration of the gum. After the tooth is removed, it should receive the following treatment: Remove from the root or roots, with the proper instrument, all coagulated lymph, diseased periosteum, and any foreign substance that may be present. The cavity of decay, if one exists, the pulp-chamber, and canal in the root or roots, should all be perfectly cleansed, formed, and filled permanently. This will occupy from thirty to sixty minutes. This part of the work should proceed as rapidly as is consistent with thoroughness. Immediately after the removal of the tooth, there should be placed in the socket from which it was removed a pledget of cotton moistened with some preparation that would be acceptable to the part, and that will prevent, so far as may be, the coagulation of the blood while the tooth is out of the socket. For this purpose the tincture or the infusion of calendula (marigold) has been used, and also

hamamelis virginica (witch hazel) extract; both of these have been used with apparent good results. Some, however, prefer to use nothing of the kind for this purpose, but rather permit the blood to coagulate in the socket, and remove just before inserting the tooth.

The tooth having been prepared as above described, should now be carefully replaced in its socket; the jaws should then be closed firmly, which will carry the tooth to its precise position. Ordinarily, no stays or ligatures will be required to hold it in position.

Just previous to the replacement, the pledget of cotton will be removed, and any debris that may be found, clots of blood, and, indeed, any and everything that does not properly belong to the part as living structure, should be taken away. Usually, the tooth will become firmly attached within a few days. This mode of treatment is practicable even when the fistulous opening has been formed through the cheek to the external surface.

In regard to the treatment of alveolar abscess, much yet remains to be learned. With the attainments thus far made in this direction, no aspiring dentist will rest satisfied, though in the hands of a few it has made great progress within a very recent period.

In a treatise of this character it is impracticable to enter into the details of the pathology of this affection, or very minutely into the rationale of its treatment. A thorough knowledge of these involves a wide range of pathological knowledge.

CHAPTER X.

PIVOT TEETH.

Whenever the crowns of the anterior teeth have become so much decayed that they cannot by filling be rendered useful, they may, under favorable circumstances, be supplied by artificial crowns constructed on the roots. For the successful accomplishment of this work, the following conditions are important:—

First. The constitution of the patient should be good.

Second. The mouth should be in a healthy condition, and without diseased teeth or roots.

Third. The teeth should be free from calcareous deposits, and from all foreign substances liable to induce irritation or inflammation.

Fourth. The attachment of the teeth should be perfect and healthy.

Fifth. A root having a living, healthy pulp is to be preferred to one the pulp of which has been dead for some time.

Sixth. The root above the neck should be sound.

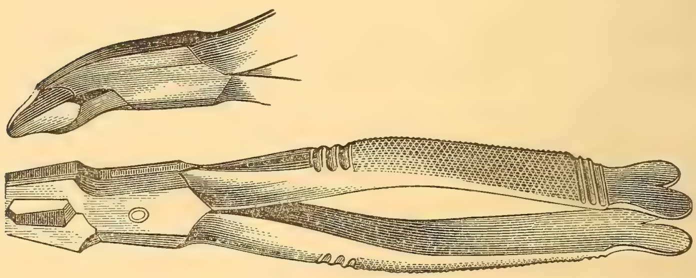
Seventh. The root should occupy a correct position in the arch. Prior constitutional treatment will often be required where there are unfavorable conditions.

The roots of the six superior anterior teeth are better adapted for the reception of artificial crowns than those of any other in the mouth. The roots of the first bicuspids frequently terminate in two points, and are always more or less compressed, so that they will not receive a pivot large enough to sustain a crown; besides, these teeth are masticatory, and crowns pivoted to them very soon become loose and useless. The roots of the inferior incisors are also compressed, and thus subject to the same disability. Occasionally, however, pivot crowns are attached to the roots of the superior bicuspids, and the inferior incisors, cuspids, and bicuspids. But in order that such an operation shall be of any utility, the conditions must be favorable, the roots with as little lateral compression as possible, in a very sound and healthy state, and without any tendency to inflammation.

The preparation of the root for the reception of an artificial crown is a very simple process. It will, however, be somewhat modified by the kind of crown used, and the method of attaching it. Ordinarily, the first step is to remove the natural crown, or any

remaining portion of it, with a fine saw or excising forceps. Of this latter instrument there are various forms, that in most common use having narrow transverse edges, closing squarely together, as represented in Fig. 93. With these forceps any broken

Fig. 93.



fragments of the crown can be removed with great facility. Many operators, placing their edge on the neck of the tooth, are accustomed to excise with them the principal part of the crown at a single cut. This method, however, is objectionable, since it always gives too great a jar to the root, and is liable to loosen, and in many instances to fracture it, so as to unfit it for the reception of the crown. But in every case in which an artificial crown is required, the natural crown is very much decayed, and in this condition is very readily removed with excising forceps, nipping it off in fragments, beginning where it is weakest and thinnest, and encroaching on it till it

is all cut down—at least as far as the forceps are available. Yet care is necessary even in this manner of using the forceps, least the root be fractured or too much jarred.

After such excision with the forceps, the root is to be dressed down for the reception of the crown, with a round or, better, an elliptical file. But for this operation of removing a crown, a very fine, smooth, narrow saw, set in a frame (Fig. 94), is in some

Fig. 94.

respects preferable to the forceps, it being less liable to injure the root than the latter. With this the crown is sawed off at the margin of the gum, leaving the end of the root about the form required for the reception of the artificial crown. In the process, the crown being sustained by the fingers, the saw, kept constanly wet, is applied to the tooth, and passed along its proximal side to the margin of the gum, and then along this through it, cutting it off at right angles with its axis. After the crown has been thus cut off, the root is fitted with a fine, round file, for the artificial crown; and, ordinarily, it should be dressed at right angles with its axis.

At this stage of the work, if the pulp remains alive, it should be removed; and the preferable

method is by direct operation, in the manner already described (pp. 307–8). It is better in all such cases to avoid the use of arsenic for destruction of the pulp: it will often be necessary to destroy it before the crown is removed. For a successful operation, it is always preferable that the root have the pulp living. After it is removed, the canal is to be enlarged to a suitable size, with the appropriate drill. If there is any remaining sensitiveness of the dentine, as is very seldom the case, the bur drill may be used for this purpose; but if not, then the common spear-pointed drill will be best. Where, however, the canal takes the form of a mere fissure, either the bur drill or the four-sided broach may be employed. The depth to which the canal should be enlarged will be determined by the length of the root, but it should in all cases be sufficient firmly to retain a pivot, which is from one to two lines; and the diameter of the hole will be determined by the size of the root. The drills should be frequently moistened with water, to prevent their clogging. The shaft of the instrument in the operation should be in a line with the cutting edges of the two adjoining teeth, and midway between them, and the drill itself should follow the natural canal as nearly as possible.

FITTING THE CROWN.

The tooth selected should be of a size, shape, and color to correspond with the natural crown which it is to represent. It should not be ground on the sides or point, and, according to general opinion, ought not to be touched with the emery-wheel at all. A different opinion, however, is entertained by Dr. C. Palmer. He suggests the grinding of the entire anterior surface of the artificial crown, thus removing the vitrified surface of the enamel, by which it is claimed that the appearance corresponds much better with that of the natural teeth, which, in many cases, at least, is correct. The diameter of the neck of the crown should correspond with that of the articulating surface of the root to which it is to be attached. In fitting the crown to the root, the joint should be made as nearly perfect as possible, for the tooth is thus more permanent and comfortable; an open joint offers a receptacle for the lodgment of food and other foreign substances, where they become vitiated, and produce unpleasant if not injurious effects. The crown may be principally fitted to the root without a pivot, by dressing the latter with a round or elliptical file, and frequently trying the crown on in its proper position. After having been thus pretty accurately fitted, a trying pivot of soft wood should be intro-

duced, by means of which, grinding it to its exact position, the crown may be fitted to the root in its proper position.

For fitting pivot teeth, Dr. E. Townsend invented a round file, with a counterpart, into which the file exactly fits; with the former of these the root is dressed, and with the latter the articulating surface of the crown. This apparatus would be good were it not for the great difficulty of dressing porcelain teeth with a file. By care, a very complete fit can be made with a round file alone. Some coloring material, as rose pink, for instance, may be put on the base of the crown, and then the tooth, with the pivot inserted, set in its place, when the root will be marked where the crown has touched it, and this can be dressed at the point of contact. This operation is repeated till a perfect fit is obtained. This method is to be recommended to those who have had but little experience in adjusting pivot teeth.

Another method of making the articulation, is to dress the end of the root square, and then counter-sink it about half a line deep with a square-ended bur, about three-fourths the diameter of the root. The base of the crown is then ground down, by the measure of the bur, perfectly round, so as exactly to fit into the depression in the root. The bur used for counter-sinking the root should have a centre-point to

fit into the hole in the root, and thus guide the instrument. This method of fitting on crowns is objectionable, by reason of its too great exposure of the root of the tooth. Fig. 95 represents the bur used for

Fig. 95.

this purpose. It is a method now very seldom employed.

Still another method of making an articulation is, to dress up the root as first described; then take an impression of the part in plaster of Paris, and from this get a model to which to fit the crown. This method, however, is advisable only in cases where it is desirable to avoid annoyance to the patient by a tedious fitting process.

ATTACHMENT OF THE CROWN.

The means of attachment in most common use is that of wood pivots; for these, wood in the natural condition is ordinarily employed, though it is much improved by compression. The kind best adapted for pivots is the fine-grain, tough, slow-growth hickory, of straight, uniform fibre, which should be thoroughly seasoned. For its preparation, take

blocks, six or eight inches long, and split them into rods about one fourth of an inch square; then, with a knife and file, dress them down to a size one-third greater than that of the intended pivots; afterward, pass them through three or four holes of the ordinary drawplate inverted, thus making them of uniform thickness throughout; and finally, turning the draw-plate, pass them through it in the same manner as wire, continuing till the rods are of proper size, and all the pores of the wood are closed by compression. They should be slightly oiled before being drawn through the plate. They may be drawn so as just to fit the holes of the artificial crowns, being, of course, of different sizes. Pivots thus compressed are stiffer, stronger, and far more durable; and, there being greater density of fibre, there is less absorption of moisture, less expansion, and less liability to decay, than in wood in the natural condition.

In arranging the crown in position, care is necessary to prevent it from being struck by the teeth of the opposing jaw,—especially since it often happens, where the natural crown has been absent for some time, that the corresponding tooth of the lower jaw becomes somewhat elongated, and strikes forcibly against a properly-adjusted pivot tooth. Such a difficulty is met either by filing off the elongated tooth, or by grinding out the palatal portion of the

artificial crown sufficiently to accommodate the elongation. The former is the better method, and should always be adopted when inflammation of the dentine, exposure of the pulp, or an irascible condition of the surrounding parts do not forbid it: though in many instances both methods may be advantageously employed. But, by some means the antagonizing teeth should always be prevented from coming in contact with the artificial crown; and this latter should never press against the tooth on either side of it;—indeed, it is better that there be a small interval on each side.

When the crown is in its proper position, the hole in the root and that in the crown do not always have precisely the same direction; in which case, a pivot will be required, having a curvature according to the variation; and the extent and direction of such inflection should be carefully observed while adjusting the crown with the trying pivot. The pivot is to be neatly and accurately fitted into the crown first, and then the length of it required for the root ascertained

Fig. 96.

with the gauge represented in Fig. 96. This gauge consists of a wire of a size freely to enter the pivot-

hole, having a little slide with a flange attached. By introducing this wire into the pivot-hole, the slide is pressed back, and the depth of the hole indicated at once. The pivot is then cut off accordingly and dressed to the proper size and inclination, and gently pressed to its place with the thumb and fingers. Before being introduced, however, it may be wrapped with gold foil which will serve to protect the dentine of the root from decay, and also to preserve the pivot. Two or three thicknesses of No. 6 gold foil may be placed between the crown and the root, so as to make a more perfect joint and exclude the moisture. There is, however, not much advantage in an arrangement of this kind. A thin sheet of Hill's stopping, placed in the joint, makes a better adaptation than the gold, and os artificial may be used for the same purpose, and in many instances is far better than either Hill's stopping or gold; the canal in the root above the pivot should be filled with gold, though in cases where there is a discharge through the root, this would not be admissible.

The canal at the orifice is sometimes considerably enlarged by decay, so that when the crown is fitted and the canal sufficiently opened for the reception of the pivot, there will be a cone-shaped space which the ordinary pivot will not fill. There are several methods of obviating this difficulty; one of these is,

completely to fill the enlargement with gold, and then perforate this filling with the proper-sized drill for the reception of the pivot; or, which is better, to introduce into the canal a polished steel wire of the size of the intended pivot; round this consolidate a filling of gold, having first made retaining points at the proper places in the dentine; finish perfectly flush with the end of the root; and then withdraw the wire from the canal, and it is ready to receive the pivot with the crown attached. Some operators form the wood pivot of such a shape as to fit into and fill the enlarged cavity. Another method is, after the pivot is fastened into the crown, to build round it, on the base of this, a portion of Hill's stopping, of about the size and form of the enlargement in the canal; and then the tooth being ready to insert, soften the stopping by heat, and introduce it carefully into place. The os artificial in such cases is still better.

It frequently happens, in cases where the pulp has been dead for a considerable time, that there is more or less discharge through the canal of the root, and a tooth is required immediately, or at least before there is time for treatment, to abate the discharge. To such a condition some arrangement must be adapted so as not entirely to close up the canal, and preclude the escape of pus. For this purpose a groove may be cut down the wall of the canal,

or, perhaps better, on the side of the pivot throughout its length, for the discharge of the secretion. Where there is irritation or liability to inflammation, a temporary pivot of soft wood, or of hard wood loosely fitted, should be worn; for thus the root is less jarred by percussion on the crown, and, if need be, the crown and pivot can be removed.

METALLIC PIVOTS.

The liability of a pivot of wood to wear off at the point between the crown and the root, as well as to become offensive, and the difficulty of removing the tooth, have led dentists to seek some less objectionable material; and metals have been experimented upon, and found in some respects preferable. Gold has been employed for this purpose more than any other metal. Pivots made of this do not become offensive, do not wear off, and admit of any desired curve, and of an easy removal of the crown. There are several methods of attaching this kind of pivot to a tooth, and a very common one is, to fit into the hole in the crown a piece of pivot wood; cut it off even with the base of the crown, and perforate it with the proper-sized drill for the reception of the metal pivot, which may be roughened or barbed on its sides, and then forced into the place prepared for

it. Another method is to drill into a block of wood; insert the pivot, prepared as above, then dress down the wood round it till this will fit closely into the crown; and after it is pressed in, cut off the protruding portion of wood. In either of these methods, when the wood becomes moist, the metal pivot will be very firmly retained. This pivot may also be attached to the crown by soldering. Place the edge of the tooth in plaster of Paris; set the pivot in its proper position in it; fill this round with fragments of gold plate, and put on solder and borax; heat up with a blow-pipe, and draw the solder to the bottom of the cavity. Another method, sufficient for all practical purposes, is to set the pivot in place, and pack round it a stiff amalgam of gold and mercury; evaporate the mercury by heat. A better method than any of these is to have teeth manufactured with a platinum tube inserted, into which the pivot can be soldered. Pivots may also be attached to the ordinary plate teeth.

For attaching the metal pivot to the root, it is sometimes fitted tightly to the canal, and introduced into it without any other substance. This is objectionable on account of the wearing of the root, certain to take place if there is the least jarring or moving of the crown. To obviate this, various methods have been devised, one of which is to wind floss silk about

the pivot before introducing it; but this soon becomes offensive, and requires frequent renewal. Another method is to introduce a piece of wood into the root, and drill through it for the reception of the pivot, which is squared and roughened,—squared to prevent it from turning round, and roughened to secure it from drawing out. But if it is desirable to remove the tooth occasionally, the pivot should not be barbed.

Metal tubes may be introduced into the roots for the reception of the pivots. These tubes are made of hollow gold wire of proper size, the method of preparing which is, to take a piece of No. 30 gold plate, from four to six inches long, and from a third to a half inch wide, and bend it round a piece of smooth polished steel wire of the size of the intended pivot; draw both together through a drawplate, down to one size larger than the hole in the root; then take out the wire, and solder up the tube; on it cut a fine thread with a screw-plate; from it cut off from a half to three-fourths of an inch in length, and insert into this a piece of the wire it was drawn upon; grasping this section with a small vice or pair of nippers, screw it carefully into the root; and having introduced it far enough, withdraw the piece of wire, cut off the protruding piece of tube with a fine saw, and file and neatly polish. The root is thus ready for the recep-

tion of the crown, the pivot of which should fit very accurately into the tube. A very slight curvature of the pivot will enable it to retain a very firm hold in the tube. The tube's inner end may be soldered up if desirable; and if there is decay at the orifice of the canal, a flange may be soldered on to its outer end, flush with the end of the root, and the decayed cavity filled beneath it, the flange serving to retain the filling perfectly in place. These tubes can be best fitted in with the screw, though they are sometimes placed in without this, and gold foil packed about them to retain them. They may be made to receive a square pivot, by being drawn, in their manufacture, on a square wire instead of a round one. For the escape of pus, as already referred to, the pivot may be made of hollow wire, with a hole through the crown of the tooth.

A plate tooth, with a metallic pivot attached, may be used instead of the ordinary pivot tooth; and it is in some cases required, on account of the manner in which the teeth antagonize. But in all cases where a plate tooth is used, it should have a metallic base to rest on, and cover the end of the root. Properly to construct this, an impression must be obtained, and models and counter-models made, and the base swaged; and then to this the pivot and tooth are attached. Irregularity of the teeth, and

especially of the root on which the crown is to rest, may require a peculiar adjustment of the pivot, which may be very happily effected by the method just referred to.

Occasionally, bad consequences follow the operation of inserting a pivot tooth, the most frequent of which is inflammation of the periosteum. Rough manipulation is very liable to induce this condition, where there is an inflammatory diathesis, in which case too great care cannot be recommended; and prior treatment will sometimes be advantageous. After periostitis has supervened, either constitutional or local treatment, or both, may be employed,—constitutional, by emetics and saline cathartics, and, indeed, any agent that will equalize the circulation and counteract the inflammation; and local, by the same means as already prescribed for periostitis elsewhere; in addition to which, it may sometimes be necessary to remove the crown and pivot from the root. It is always important to commence the treatment of such cases at the first indications of the disease.

Sometimes, even with considerable care, a crown will be split by the introduction or the expansion of the pivot, in which case, of course, another tooth must be selected. When a pivot breaks off, and a portion adheres in the root, this may be drawn out

with pliers, or a pivot-extractor, or, if it does not protrude enough for this, it may be drilled out. A root is sometimes split by the expansion of a tightly-fitting pivot, or by a blow on the crown of the tooth; and when this happens, it must be removed, since it cannot be made longer to retain a tooth. Pivot teeth should seldom, if ever, be worn in a mouth in which teeth on plate are worn. They are now far less frequently worn than formerly, because, perhaps, of the improved method of inserting teeth on plate. Under favorable circumstances, however, they may be worn with great comfort and usefulness from five to fifteen years.

CHAPTER XI.

EXTRACTION OF TEETH.

GENERAL REMARKS.

The extraction of teeth is an important operation, requiring for its proper performance skill, judgment, and experience, as well as an accurate knowledge of the parts involved. Success in the operation formerly was very uncertain; but now, from an increase of knowledge in the art of dental surgery, and from great improvements in the instruments employed, the operation is generally attended with success. The ancients were not strangers to this operation, as is evidenced by relics found in ancient tombs, with teeth absent, under such circumstances as to warrant the conclusion that they were removed by the surgeon. Extracting instruments of very ancient date have also been found; and ancient writers, too, refer to the operation as one not much more pleasant then than now. The demand for this operation rises not from fancy, fashion, or caprice, but from dire necessity—a necessity, too, of great frequency. Very few individuals in this country arrive at a mature age

without being required to submit to it; and, indeed, the majority, before middle age, lose in this manner from four to ten teeth, and many, all. The following are some of the objects for which a resort is had to this operation:—

1. To obtain relief from pain, caused either by disease of the pulp, by inflammation of the periosteum, or by any other affection involving the teeth, that cannot be readily controlled without their removal.

2. To prevent pain in future. This, of course, has reference only to those teeth which are very much decayed, or rendered useless by any cause, and which are liable at any time to occasion disease in the parts about them.

3. To save sound teeth from the attack and ravage of decay. This implies those teeth which, by their offensive condition, would prove injurious to healthy teeth.

4. To relieve a diseased condition of the contiguous parts, such as alveolar abscess, neuralgia excited by dental irritation, diseased antrum—and sometimes, indeed, remote parts, which are in many instances affected by diseased teeth.

5. To anticipate and obviate irregularity. Of this there are many cases, in which all the teeth cannot be accommodated with a proper position in the arch,

and in which the removal of one or more of them for this purpose becomes a necessity, if regularity and symmetry are to be secured.

6. To prepare the mouth for a proper reception of artificial teeth on plates; though plates are sometimes inserted, with the roots of the teeth remaining, which is admissible only when the roots and the parts about them are healthy; otherwise they should be removed.

Before anything else is done, every case presented should be carefully examined, in order to ascertain all the circumstances and conditions that might in any way affect the operation. It is important to arrive at a correct conclusion in regard to the tooth or teeth to be removed; the number of roots, their inclination, and the character of their attachment; in what manner, and to what extent, the surrounding parts will be affected by their removal; and the probable amount of force necessary for this purpose. The operator will in many instances be referred to the wrong tooth; for a sound and healthy one is sometimes painful from sympathy, and standing in contact with a decayed and painful tooth, makes it frequently difficult for the patient to determine in which the pain exists; and sometimes difficult for the operator, too, especially where the decay is on a proximal portion of the tooth, and not easy of

approach. In all such cases, great care should be exercised, and a thorough examination made. There is often extensive decay on the proximal portion of the tooth, that is not apparent at first view.

The constitution is also to be noted—its peculiarities, tendencies, and susceptibilities; as these will often modify the operation. A highly nervous temperament will not endure an operation that one of a different character will undergo with impunity. There may also be idiosyncrasies and conditions that will forbid the extraction of a tooth. One of these, and not the least formidable, is a hemorrhagic diathesis.

The manner of performing the operation is an important consideration: it should not be precipitate or hurried. A very good criterion is, that the eye should critically follow, and the mind attentively comprehend, every movement of the hand and instrument. It is a very common method to seize the tooth, turn away or shut the eyes, and make the most rapid motions possible, regardless of consequences. Accidents, such as breaking the tooth, fracturing the alveolus, laceration of the soft parts, and rupture of the blood-vessels, are very liable to follow a hurried execution; and there are many cases on record in which injury has resulted from a rapid application of force in the extraction of teeth. The ancients were

cautious in this particular: it is recorded of them that they made extracting instruments of lead, to prevent injury from the employment of too great force. It is difficult, indeed, always to determine what amount of force may be necessary for the removal of a tooth in any given case; though by long and close observation, it may be pretty accurately calculated; and it is important for the operator to know it, so as to prepare for the emergency, and to select the instrument appropriate to the occasion. In order to be successful, an operator must be confident of his ability, and to be so, he must be possessed of it. He should be familiar with the anatomical structure of the parts to be operated upon; should understand the physiological and pathological conditions of the parts adjacent; and should properly appreciate their influence on, and their connection with, the teeth.

There is a great difference in teeth with regard to their facility of removal. Those most difficult to extract possess the following peculiarities: shortness and thickness of crown; in the incisors, thickness—the edges of the superior and the inferior meeting squarely on, or deviating but little from their points; freedom from prominences on the crowns of the molars and bicuspids, their masticating surfaces being smooth; regularity in arrangement, all being in cor-

rect position and in contact with one another; color slightly yellow; denseness and thickness of alveolus; unyielding firmness of the soft tissues; lack of prominences on the gums to indicate the size and position of the roots. Another class of teeth, differing in characteristics from those of the above, are also very difficult of extraction, namely: those having crowns of medium length and of a diameter at the neck much less than at the masticating surface; roots long and divergent, and in some cases considerably curved; and often a very firm union with the alveolus, so that a portion remains adhering to the tooth when it is extracted, which occurs more frequently with the superior cuspid teeth than with any others; and often the septum betwen the roots is so firmly embraced by them, especially when they converge, that it is brought away with the tooth on its extraction. Bony union of the teeth has been enumerated as one of the occasional obstacles in extraction of the teeth; but this rarely if ever occurs—the mode of development almost precluding the possibility of its existence—so that it need scarcely be reckoned. Exostosis of the root sometimes renders extraction very difficult, especially when the enlargement attaches to the point of the root, and forms a bulb larger than the diameter of the root elsewhere. It is then like a ball in a socket, and if the walls of the alveolus are thick and

firm, and closely embrace the root, the tooth is very securely retained. Exostosis of the same extent in the inferior as in the exterior teeth will render the latter the more difficult to remove, because of the greater density of the inferior maxilla; and it has been maintained that this cause would produce a like difference even in the normal condition of the organs; but experience does not warrant the opinion. The superior molars have more numerous and more divergent roots than the inferior; and the roots of the anterior superior teeth are much larger, and consequently have a greater amount of attachment, than the anterior inferior ones. In a healthy condition, the periosteum of the root has comparatively little sensibility; but in proportion as it is subjected to acute disease, is the sensibility, and thus the pain consequent on the removal of the tooth, augmented.

Instruments adapted to all the different forms and locations of the teeth are requisite in the various operations of extraction. It is impossible to remove all teeth in a proper manner with but three or four instruments, as recommended by some.

For any kind of successful manipulation in the mouth, and especially that involved in the extraction of teeth, the patient should be placed in such a position as to make him the most comfortable, and to

secure to the operator the greatest facility of execution. But different positions, of course, will be required for the removal of different teeth. Finally, there should be as little show of preparation, and as little display of instruments, as possible,—thus to avoid exciting the nervous apprehensions of the patient; and the operator should at all times exhibit a gentle and encouraging deportment, yet work promptly and surely.

INDICATIONS FOR EXTRACTION.

The most common and imperative indication is, continued and violent toothache. In all cases where the teeth are diseased and painful, and cannot be restored to health, they should be removed. There are, however, few cases of diseased teeth that cannot be relieved by the present methods of treatment, so as to remain in the mouth with some degree of comfort and usefulness. Alveolar abscess, terminating on the outside of the face, or tending to it, always indicates the removal of the offending tooth. Chronic inflammation of the investing membrane used to be considered an indication for extraction; but it is found that many cases thus affected may by judicious treatment be restored to comparative health. Ulceration of the investing membrane clearly points

to extraction as the remedy. Teeth that have no antagonists, and that, on this account, keep up an irritable condition in the contiguous parts, should be removed; and so, as a general rule, should supernumerary teeth. In order to relieve a crowded condition of the teeth, it is sometimes necessary to remove one or more, even though they may be healthy.

Till within the last few years, the existence of an alveolar abscess was considered an indication for the removal of the tooth from which it proceeded, but under the present mode of treatment, except in very aggravated cases, a simple abscess is not reckoned a sufficient cause for extraction.

The posterior teeth may be removed for causes that would not warrant the removal of the anterior. All dead teeth and roots that produce or keep up irritation should be removed, especially if the tendency is persistent.

The temporary teeth that are not cast at or near the time their respective permanent teeth should appear through the gum, ought to be removed; but caution must always be exercised, lest they be removed too soon. Painful and uncontrollable disease may indicate their removal long before the period just mentioned; yet they should not be removed on account of diseased condition unless the rudiments of

the permanent teeth are likely to suffer thereby. A crowded condition of the permanent with the temporary teeth may indicate the removal of one or more of the latter. It is important to understand the true indications for the removal of temporary teeth; in these, as in the permanent teeth, apparent indications are liable to be mistaken for real ones. Teeth may sometimes, even though undecayed, produce nervous affections, and in such a manner as to render their removal necessary. This indication is most frequent with teeth affected by exostosis.

A high state of inflammation in the contiguous parts is regarded by some as a counter indication; but it can be such only in cases in which the inflammation would be increased by the operation; and this would happen only where there is a decided inflammatory diathesis, which peculiarity can be readily detected by careful observation.

EXTRACTING INSTRUMENTS.

Numerous and various instruments have been employed for extracting teeth; and each of these has passed through various modifications. Imperfection and want of adaptation have, till within a few years, characterized them all in a marked degree, as indicated by the numerous changes they have undergone.

Two general classes comprehend them all, represented by the key and the forceps. The former makes its attachment on one side of the tooth, coming in contact with but a small portion of it, and has a resting point for a fulcrum on the adjacent parts, the gum and the alveolus. The latter embraces the tooth on both sides, and has no fulcrum resting on the adjacent parts. There are other instruments somewhat different from these in their application; but the principle on which they operate is the same. For instance, the elevator has a point of embrace or contact with the teeth, and a fulcrum or resting point on the adjacent parts, the power being applied to the handle, as to a lever. The screw makes its attachment inside of the tooth, instead of outside, like the forceps, and does not touch any other part.

There should always be at hand a sufficient number and variety of instruments to meet every case, however rare its occurrence. Desirabode recommends the employment of but four instruments for the removal of all the teeth. The first is a forceps, and the other three are nothing more than so many different forms of the elevator. He was not familiar with the present improvements in extracting instruments, or he could not have made such a recommendation.

THE KEY.

The principle of this instrument was at a very early period brought into requisition for the extraction of teeth; it is emphatically an old instrument. It consists of a shaft six inches long, with a handle four inches, attached at right angles, while the hook is attached laterally at the other end of the shaft, and the bolster, either movable or fixed, to the side of it, immediately below the articulation of the hook. This instrument has passed through a great variety of forms and modifications; having the shaft straight, curved, or double curved; the fulcrum large, small, flat, round, long, short, fixed, movable, and anterior, posterior, or opposite to the point of the hook. There has also been a great variety of forms of the hook; and it has been made with machinery attached, to control its grasp, the object of which is to prevent the instrument from slipping off the tooth, and skill in the use of which would doubtless add to the efficiency of the instrument. The principle of the forceps, too, has been combined with the key, and probably with very decided advantage.

The *modus operandi* of the key is worthy of some consideration. The hook is attached to the shaft directly above the bolster, and starts off at a right angle with its vertical axis, but curves down to the

point, almost or quite as low as the base of the bolster. When properly constructed, the hook embraces the tooth at the neck on one side, and the bolster rests a little below this on the other. When the instrument is applied to a tooth, the centre of the shaft is the axis of motion; but as force is applied to the instrument, this axis is transferred from the shaft to the base of the bolster, which is the centre of motion the moment it is fixed on the gums and alveolus, and the shaft describes an arc about it. Now, as a result of this motion and arrangement, the line of force is at an angle of from forty to sixty degrees with the axis of the tooth; and hence it is at this angle that the tooth must be extracted, if at all. The axis of power exerted on the tooth by the instrument is in a line from the point of the hook to its attachment to the shaft; and the line of this force has its termination below the neck of the tooth on one side, and just above the crown on the opposite side. The angle formed by the line of power with the axis of the tooth is different in the different relative positions of the key to the tooth. If the instrument is applied to an inferior molar, with the bolster on the inside, the angle of the line of force with the axis of the tooth is about forty degrees; but if placed on the outside of the jaw, as recommended by some, the angle contained by the line of power and the axis of the tooth

is sixty degrees or more. The line of force is not changed by any form the hook may assume ;—it may be regularly or irregularly curved, or be turned at right angles, and yet the line of force is not changed. Indeed, this line cannot be changed except by changing the relative position of the hook and its attachment. This application of the power constitutes one of the prominent objections to the use of the instrument; the force is applied at too great an angle with the axis of the tooth, and hence, in numerous instances it is broken off. The bolster of the key rests, in the operation, on the gum, on which it exerts great pressure, and which it always bruises, and frequently lacerates in a cruel manner; the pressure exerted by the bolsters of the variously constructed keys differs but little; though, perhaps, the bolster which has a broad base, and is attached to the shaft by a joint, would cause less pain to the patient by its pressure, and be much less liable to lacerate or cut the gum, than the small and permanent one. The pressure of the bolster on the gum and process is always greater than the power required to extract a tooth; and this extreme pressure and its consequences constitute another strong objection to the use of the key. The power being applied at a disadvantage, much more is required than when economically applied.

This instrument is so seldom employed for the extraction of teeth, that any very special directions as to its use will scarcely be required; yet a few general suggestions may not be out of place. Whether a tooth should be drawn inward or outward depends on its position and inclination. As a general rule for the removal of the molars, the bolster should be placed on the inside of the inferior teeth and on the outside of the superior. For removing the lower teeth of the left side, the operator should stand at the right of the patient; and for the teeth of the right side, in front or at the right. For the inferior teeth of the right side, he should stand at the right of the patient; and for the left superior, in front of him. There have been a great many different opinions as to the manner of applying and using this instrument. One recommends that "the teeth should be always turned towards the tongue." Another, "that the fulcrum should be so placed that it would not come in contact with the tooth." Another directs: "Place the fulcrum on the margin of the gum." Another: "Place the fulcrum on the gum below its margin." Another suggests, "that the fulcrum be placed on the side of the tooth opposite the point of the hook." Again, we are directed that the tooth should be drawn from the higher alveolus." This great diversity of opinion as to the manner of using the key, as well as

the great variety of changes in its form, is evidence that it is, at best, a very imperfect instrument. It is impossible to embrace a tooth as deep with it as with well-constructed forceps; and with it, the liability to accident in the extraction of teeth is much greater than with any other instrument. A strong advocate of this instrument says that the key *always* produces injury; but the greatest skill exhibits the least injury."

FORCEPS.

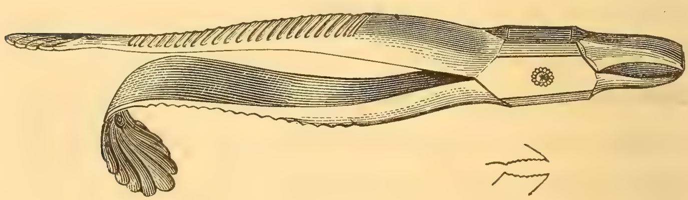
The forceps are the most efficient extracting instruments in use, and the improvements made in them during the last few years have been very great; indeed, twenty years ago they were not made with any special adaptation whatever, and were totally unfit to be used for the extraction of teeth; but now they are constructed with such various shapes and curves, as to facilitate their approach to the teeth, whatever their position in the mouth may be, and to fit all the various forms, and make the most perfect embrace of the teeth possible. Forceps, with the present improvements, take a deeper and more thorough hold on the teeth than any other instrument. The beaks may be made so thin that they will penetrate between the roots and alveolus, and the adaptation so

complete that the instrument will not slip or move from its position when placed. The form of the beaks should be such as to fit the crown without pressing on it, and yet perfectly embrace the neck of the tooth; and the entire instrument of such form and curve as to give to the hand, arm, and body of the operator the best position for ease and facility of execution.

There are various opinions as to the position, relative to the patient, which the operator should occupy while extracting teeth with the forceps. Some recommend different positions for the removal of different teeth; but it is preferable, on many accounts, to occupy as nearly as possible the same position in the removal of all; and this is to the right and a little back of the patient.

The forceps for removing the superior incisors are straight, and have thin beaks, which are sufficiently broad to embrace the anterior and the posterior surfaces of the teeth entire (Fig. 97); and they should

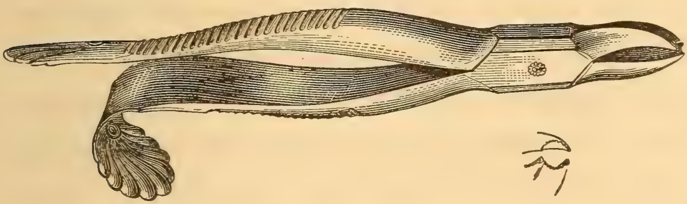
Fig. 97.



be much broader for the centrals than for the laterals. The points should not be so broad, however, as to

come in contact with the contiguous teeth in the rotary motion made to break up the attachment. The same principle in regard to the width of the forceps is to be observed for the lateral incisors and cuspids. The ordinary straight root forceps may be employed for the extraction of the lateral incisors; though, for this purpose, it is desirable that their beaks be somewhat thinner than usual. For the superior cuspid teeth, the ordinary bicuspid forceps are frequently used, but their beaks are commonly too narrow, and those of the central incisor forceps too thin. The cuspid forceps should be about as wide as those for the central incisors, with the thickness of the bicuspid forceps (Fig. 98), and with a

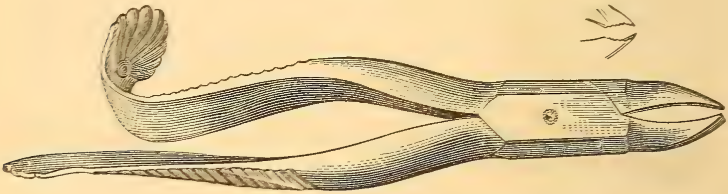
Fig. 98.



greater concavity, so as to fit the neck of the tooth. The superior bicuspid forceps have narrow, thick, and quite concave beaks, and the instrument is straight, or nearly so; though for the second bicuspids, especially in a small mouth, it should have some anterior curvature. (Fig. 99.) One pair of forceps will serve for both sides, though it is desirable to

have one for the fist and another for the second bicuspid. For the removal of the bicuspids, there is

Fig. 99.

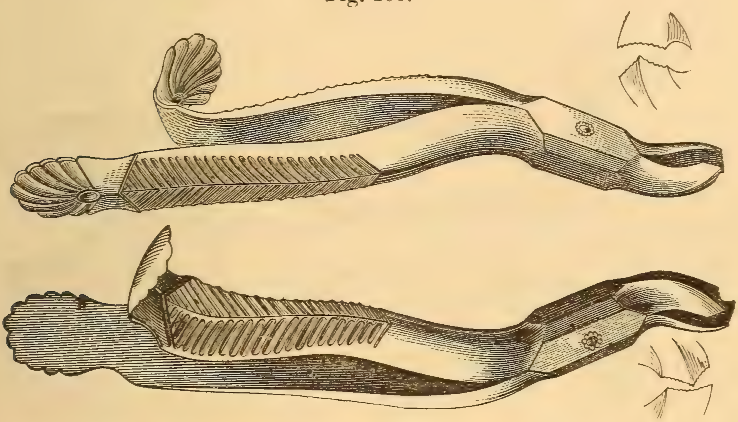


a form of forceps with thick, smooth beaks, and of such a form as, by pressure, to force the tooth from its socket, taking advantage for this purpose of the conical form of the root. The superior molar forceps, a pair for each side, have one of the beaks a single concave, to embrace the palatine root, and the other a double concave, with a projecting point from the centre of the beak, to pass into the bifurcation, and with the edge of the beak so formed as to embrace the two palatine roots. The concavity and curvature of the beaks should be just sufficient to accommodate the crown of the tooth. These forceps should have a double curve, to facilitate their approach to the teeth—an anterior curve just above the joint and a downward curve just below it; sometimes, also, a lateral curve above the joint, throwing the instrument more toward the angle of the mouth. (Fig. 100.)

For the second molars, the forceps should have a little more curve above the joint than for the first.

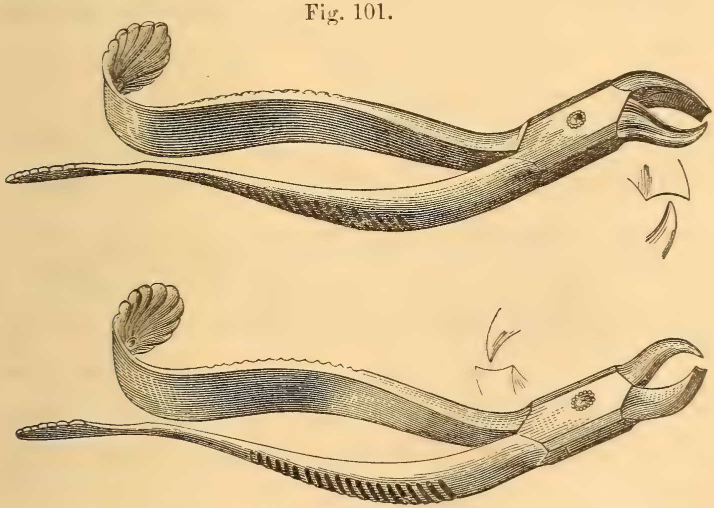
A third pair of forceps for these teeth, and especially for the roots before they are separated, have the

Fig. 100.



inner beak similar to the one above, and the outer a curved, attenuated, sharp point, to pass between the

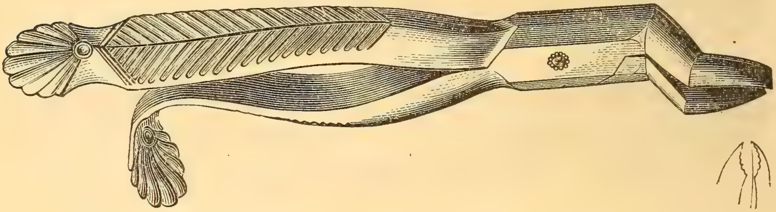
Fig. 101.



buccal roots (Fig. 101). The forceps for the superior *dens sapientiæ* have two single-concave beaks, made

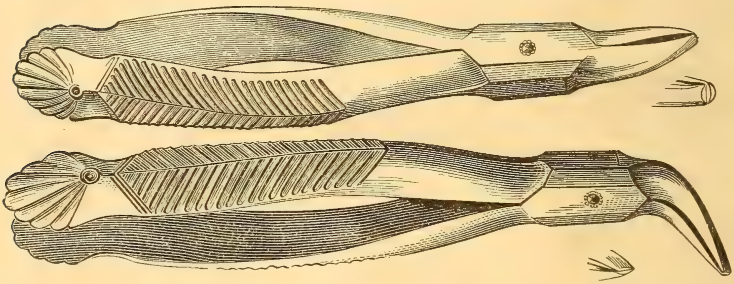
to embrace the tooth, as though it were cylindrical, or nearly so, at its neck. The instrument has two curves, or rather angles, the one forward and the other downward, so that its handle is somewhat anterior to, but almost parallel with, the axis of the tooth. (Fig. 102.) It is a principle that should be

Fig. 102.



observed in all forceps, that the handle of the instrument when placed upon the tooth be as nearly parallel with the axis of the latter as possible, and as

Fig. 103.

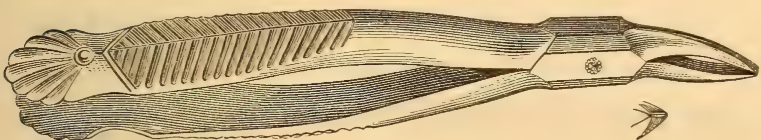


nearly in a line with it as the location of the tooth, the size of the mouth, and other circumstances will admit.

The forceps for the inferior incisors may have either a lateral or a transverse curve,—almost to a

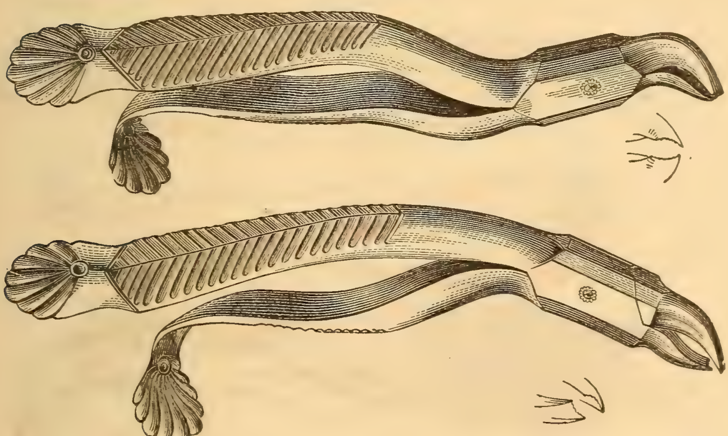
right angle if transverse, but if lateral, not more than half that inclination. (Fig. 103.) The ordinary, slightly curved root forceps may be used for the extraction of these teeth. (Fig. 104.) The

Fig. 104.



beaks should be very narrow and thin, for a great amount of force is not required for the extraction of these teeth. The beaks of the inferior incisor for-

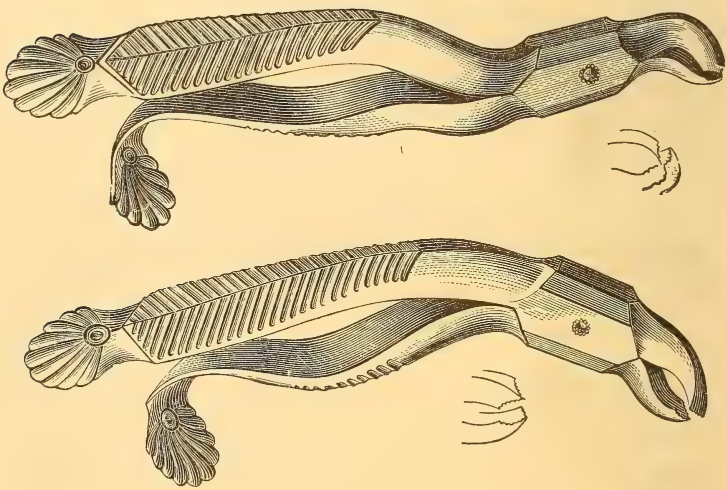
Fig. 105.



ceps should be relatively broader than those of the forceps for the superior incisors. Rotary motion in the extraction of inferior incisors is not admissible unless the roots be cylindrical, or nearly so. The inferior bicuspid forceps are well adapted to the re-

moval of the inferior cuspids also. These forceps, two in number, one for each side, are of different forms. (Fig. 105.) The beaks are narrow, thick, and quite concave. The instrument for the right side has a lateral curvature, which brings the handle out at the angle of the mouth, and is necessary in order to obviate a contact with the superior teeth. The forceps for the left side have beaks of the same form. They are bent to almost a right angle above the joint, while below it the handle is thrown upward; and their inner beak is longer than the outer. The inferior molar forceps (Fig. 106) are two in number, that for

Fig. 106.

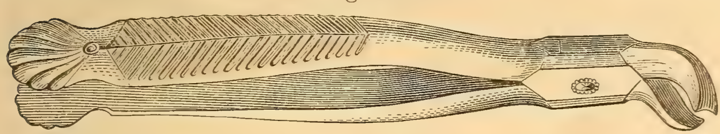


the right side being curved outward and forward, and that for the left forward and upward, the beak making almost a right angle with the body of the instru-

ment, and the inner beak of each being longer than the outer. The beak should be of sufficient breadth to embrace the entire side of the tooth, of double-concave form, with a ridge and a long point in the centre of the beak, to pass into the bifurcation of the roots. The inner beak of these forceps should be longer than the outer, for the teeth on which they are designed to operate have an inward inclination, and the outer alveolus is higher than the inner.

A pair of forceps for the left side, similar in form to those for the right, would be preferable to the ordinary left forceps, when the mouth can be opened wide; and the curvature of the handle of this instru-

Fig. 107.



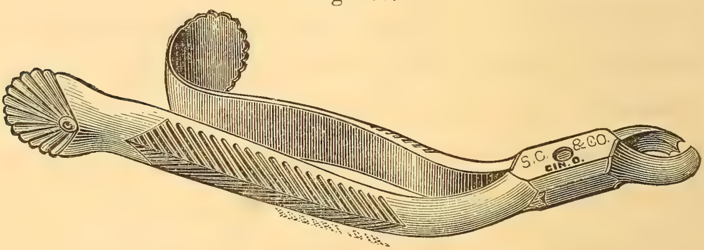
ment would be toward the centre of the mouth, instead of outward, as that of the right forceps. With this form of forceps more power can be exerted than with the ordinary left inferior forceps.

A forceps similar in general form to that for the extraction of the inferior molars of the right side has been devised by Dr. J. A. Watling, for the removal of the lower molars of the left side.

The instrument has a little more upward and forward curve above the joint than for the right side, to

facilitate its approach to and action upon the tooth for which it is designed; it is a little longer than that for the right side. This instrument is much more easily controlled than the ordinary forceps used for extracting these teeth, and with it more force can be applied. It is far preferable to any forceps hitherto used for the extraction of the left inferior molars. It is represented by Fig. 108.

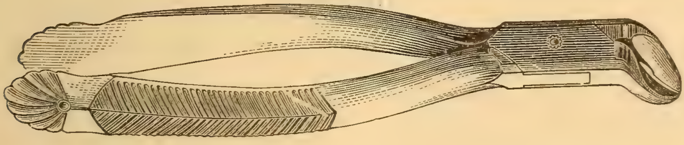
Fig. 108.



Forceps for the removal of the inferior *dens sapientiæ* have large single-concave beaks, to make a general embrace of the tooth, and have but one curve, which is between the joint and the point, and is almost a right angle. (Fig. 109.) One pair of forceps of this kind is quite sufficient for both the right and the left side. The forceps denominated *Physic's forceps* are also sometimes employed for the removal of the wisdom-teeth. These are constructed with thick, sharp blades, the edges of which come squarely together, and the points sometimes have an enlargement on them. They are curved almost to a

right angle, to facilitate their adaptation. (Fig. 109.) There are two or three different forms of Physic's forceps.

Fig. 109.

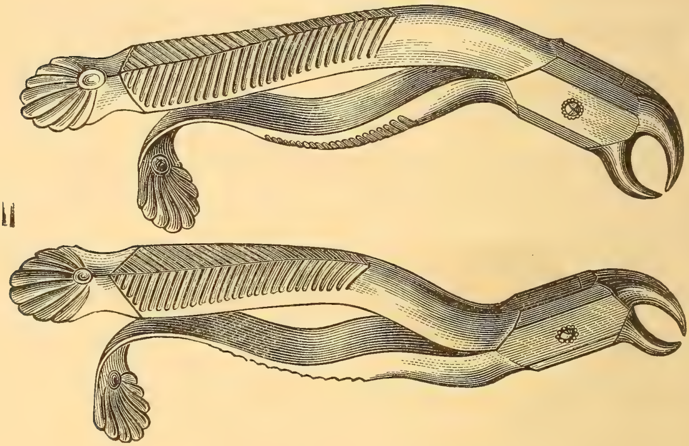


Of the variety of root forceps now used, those for the removal of the anterior teeth are straight, or but slightly curved, with long, thin, sharp-edged beaks, and of a width regulated by the diameter of the roots. Those for the removal of the roots of the superior molars, when these are separated, have the same form of beaks as those for the front teeth, but more curved, to facilitate their approach to the roots. For the removal of these roots, it is well to have several pairs of forceps with different degrees of curvature, using, in any given case, those with the least admissible curve,—which in a small mouth will be considerable, while in a large one it will be very slight. The same forceps that are used for the removal of the front inferior teeth are applicable to the removal of their roots.

Of the different forms of forceps for the removal of the roots of inferior molars, those for the extraction of the roots before they are separated, and while they are firmly attached, have two long, slender, round,

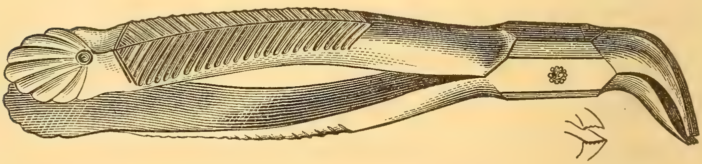
curved beaks, designed to pass down deep between and embrace the roots in the bifurcation; their curvature should be almost a right angle, and their handles

Fig. 110.



assume the form of the ordinary right and left inferior molar forceps, already described (Fig. 110); or if but one is used, the handle should be straight. The forceps for the removal of these roots after they are separated should have the beaks of the same form

Fig. 111.

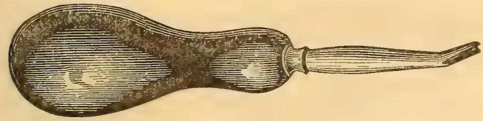


as those of the superior root forceps; but the beaks should be curved to a right angle with the handle, and the handle be straight. (Fig. 111.)

ELEVATORS.

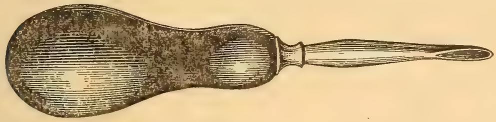
There are in use variously-formed instruments constructed on the principle of the elevator. They are made with such points as to take the most thorough hold on the teeth or roots on which they are to be used, and with such curvature of shaft as to enable them to pass most readily to the desired position.

Fig. 112.



Some are so formed at the points as to embrace the root at the border of the alveolus, using

Fig. 113.

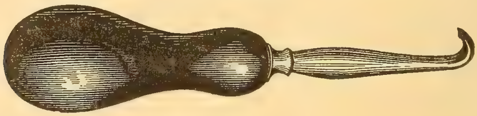


the latter as a fulcrum (Fig. 112); others, to pass between the alveolus and the root (Fig. 113); others, to cut through the alveolus, and thus approach the root. All the ordinary elevators make a fulcrum of the alveolus, or of an adjoining tooth; but some operators, in using this instrument, contrive to make a fulcrum of the thumb or one of the fingers, which is the preferable way.

HOOKS.

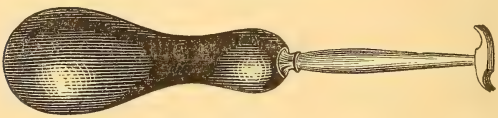
These are formed so that the point will embrace the root and remove it, without resting on the surrounding parts. The root is removed simply by

Fig. 114.



pressure, applied in the proper direction. Of the various forms of this instrument, there are the forward hook, the backward (Fig, 114), and the compound (Fig. 115), which last includes the former two.

Fig. 115.



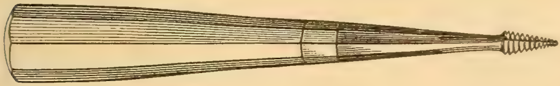
These are valuable instruments, but require care, in order to avoid injuring the surrounding parts.

SCREW.

This is a cone-shaped instrument, with a very definite, sharp screw-thread; the manner of using it in the operation of extraction is, to screw it into the root. It will be required of various sizes, to correspond with those of the different roots to be

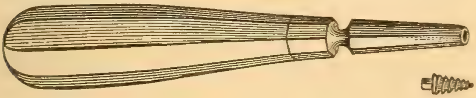
extracted. It is commonly attached to the handle by a permanent shaft (Fig. 116) ; but sometimes it is

Fig. 116.



made with a square shaft fitted into a socket handle (Fig. 117), by which arrangement the handle is used only to introduce the screw ; and this serves only as a support to a frail root, the forceps being then

Fig. 117.

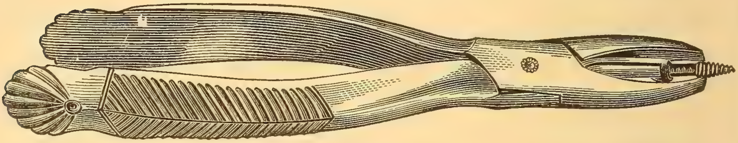


brought to bear in connection with it for the removal of the root. A screw-tap of the same form as the screw should accompany it.

When the screw is combined with the forceps for the purpose of supporting the root, and preventing it from crushing while it is removed with the forceps, the latter is of the same form as that of the ordinary straight root forceps, with the shaft of the screw attached in the joint. In some, the screw is attached with a spring and ratchet, so that it can be drawn out, seized between the beaks, and introduced into the root; and then these are slipped on the root, which they embrace and remove. In others, the

screw is fixed; but the movable screw is to be preferred. (Fig. 118.) An arm attached by a joint,

Fig. 118.

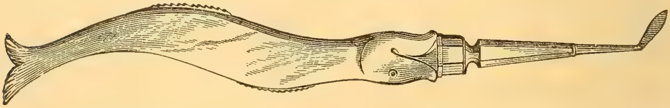


and bearing a pad, to rest as a fulcrum on the other teeth, is sometimes attached to the shaft of the screw; but this is objectionable, because of its liability to impede the action of the instrument, and also to injure the adjoining teeth.

GUM-LANCET.

Of the various forms of the gum-lancet, the most common is that with the round point, and with the blade from two to four lines wide, and from half an inch to an inch long, attached to a shaft and handle, the whole being about six inches in length. The instrument should have a keen edge on the sides, two or three lines from the extreme point. It is sometimes made with the edge square; but the round

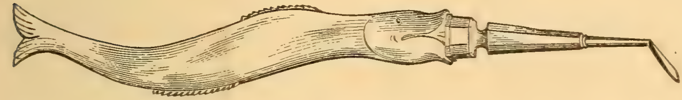
Fig. 119.



edge is the better form. The edge is parallel with the handle in the ordinary lancet. (Fig. 119.) This

form is used for separating the gum from the buccal and palatal surfaces of the tooth. A lancet with the edge transverse to the shaft is required for separating the gum from the proximal portions of the teeth. The blade of this should be of the same general form as that already described, except that it should be quite narrow—in no case more than two lines wide. (Fig. 120.) Gum lancets are made with the

Fig. 120.

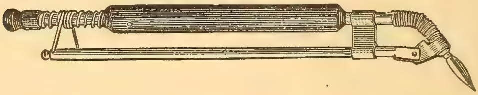


blade set in a socket on the end of the shaft, so that it can be rotated and set to any angle to meet every case.

A very ingenious instrument, invented by Dr. Merry, and denominated "Merry's Revolving Gum-lancet," was devised and constructed about fifteen years ago. This is a very excellent instrument—superior, indeed, to anything else of the kind, at least it was at that time. (Fig. 121.) The following is a description of it: "It consists mainly of two shafts: one is round and small; the other is larger, part round, and part octagon. Just back of the spiral spring which curves down at the lancet end, is seen a piece connecting the two shafts. This piece is soldered fast to the round shaft, while the upper

end of it forms a collar in which the round part of the larger shaft *slides* back and forth and *revolves*.

Fig. 121.



On the other end of the large shaft is seen a screw, made by winding a wire spirally round it. From the small shaft arises another, but shorter, spiral wire, which fits into that upon the larger shaft. The short one may be considered the nut, in which the other revolves. The ends of the short spiral are soldered fast to the small shaft. If, then, the large shaft is revolved, the screw on it, playing in the nut, is made to slide back and forth accordingly as it may be revolved. This motion, then, changes the direction of the point of the lancet to the plane of the shafts, any degree from a right angle to a parallel. Having thus got the inclination which is desired, the blade is inserted into the gum at the point at which the incision is to begin; and as the instrument cuts, rotate the larger shaft slightly, and the blade will follow the outline of the tooth as it cuts round it."

THE METHOD OF LANCING THE GUMS

In all cases the gum should be separated from the tooth as far as the embrace of the forceps is to ex-

tend; the lancet should pass close to the tooth, so as to make the separation clean about its neck;—in order to do which, the lancet must be kept in good condition; it should also be passed freely between the teeth. A complete separation of the gum is essential to a good hold of the forceps on the tooth. Some operators, however, do not use the lancet for this purpose, but tear the gum away by forcing the forceps to its position on the tooth. This method is objectionable on several accounts: it causes the patient much more pain than with a sharp lancet; the forceps cannot thus be adjusted to the tooth with so much facility; there is far more danger of lacerating the soft parts, and because of an imperfect adaptation of the forceps to the tooth, more danger of fracturing it: and the operation is always more difficult of accomplishment. In those cases in which the gum is firm and dense, and would obstruct the free passage of the forceps to the proper position on the tooth, it is sometimes necessary to make a vertical incision of the gum, even after it has been separated, directly opposite the root. But it is in many instances better to cut away a portion of the free margin of the gum in the extraction of roots that are partially covered by it; and there is no objection to this method in any case where it may at all facilitate the operation; for this portion of the gum, if let

remain, is always absorbed or sloughed away after the extraction of teeth. It is also sometimes necessary to dissect the gum somewhat from the alveolus, in those cases in which a deep hold on the tooth or root is required, and in which the alveolus is either cut away or embraced by the forceps. The character and condition of the tooth will somewhat modify the extent to which the gum lancet should be used.

EXTRACTION OF THE TEETH.

In the following remarks it is the design to consider only those principles obviously involved in the extraction of the teeth with forceps, and in the extraction of roots with forceps, elevators and screws.

Superior Incisors.—After an examination, the gum should in all cases be perfectly separated from the neck of the tooth, up to the border of the alveolus; this is quite sufficient if the tooth is not too much decayed. With the forceps already described (see Fig. 97), grasp the tooth firmly at the border of the alveolus; introduce the instrument slowly, adjusting it carefully as it passes up to the proper position; then, by a gradual movement, rotate the tooth in the socket, thus breaking up the attachment. All the cylindrical, single-root teeth may be luxated by a rotary motion. There are occasional circumstances,

however, that render this somewhat difficult—as, for instance, any considerable curvature of the root, or, sometimes, the attachment to the outer plate of the alveolus is so firm, that it cannot be broken up by rotary motion. Neither of these difficulties is usual with the lateral incisors, but with the centrals, one or other of them is not unfrequent. When either of them does occur, the attachment must be broken up by an inward and outward movement, which, on account of the pressure made on the parts, is attended with much more pain, and far greater danger to the contiguous parts, than the loosening by rotary motion.

The roots of the incisors are not difficult to remove, unless, being very much decayed, they will not sustain the embrace of the forceps below the border of the alveolus; and when they are thus decayed, one of the following methods may be adopted: The gum may be dissected from the alveolus, and the latter cut away with the thick cutting instrument, so as to expose the root sufficiently for extraction with the root forceps; or, after the gum is dissected up, the alveolus and the root may be together embraced, and the former broken and removed with the latter. This is a rough and severe operation, though it is often adopted. Or, an elevator of the proper form may be introduced between the root and the alveolus, and the root thus dislodged.

The screw, either simple or compound, is a valuable instrument for the removal of these roots. But the gum should be separated even when the extraction is to be accomplished with this. The canal in the root should first be enlarged with a taper drill, of the same shape as the screw, till all the softened dentine is removed. Then the screw, selected of proper size, having a very sharp thread, is introduced, till it takes a strong hold in the solid dentine, especially if it is the simple screw. In some instances, while it is being introduced, the root will be loosened. In using the screw in connection with the forceps, it is not necessary to introduce it with the same firmness as when the screw alone is employed. In the use of the screw-forceps, the screw is embraced in the beaks, and introduced; then the forceps are passed up on the root, or between it and the alveolus, if need be, the screw serving to sustain the root under the pressure of the forceps. The attachment of the root is broken by a rotary, or an inward and outward movement, as the case may require.

Superior Cuspids.—For the removal of these teeth, the central incisor or the bicuspid forceps may be used, though usually the beaks of the former are too thin, and those of the latter too narrow. The forceps appropriate for the removal of these teeth have broad, deep, concave beaks, so as to embrace the

tooth as completely as possible; and they are thick, so as to possess sufficient strength. The gum being separated, and the forceps adjusted on the tooth, the attachment is broken up, either by an inward and outward or by a rotary movement; the former will be far more frequently brought into requisition, since these teeth are generally so firmly attached that they cannot be loosened by the latter; but the skillful and experienced operator will often combine the two, with the happiest effect. These teeth have larger roots than any others in the mouth, and the alveolar process, especially the outer plate, closely invests them; and thus they are very firmly fixed in the sockets, and are also more frequently found curved than the roots of the incisors. Often, in extraction of the cuspids, a portion of the outer wall of the alveolus is broken off, and comes away with the tooth. But this accident is not attended with any serious results; indeed, in the preparation of the mouth for artificial teeth, it is desirable that it be broken away somewhat.

The movement in the extraction of a tooth should always be very deliberate—never sudden and violent. A very good criterion in regard to the rapidity of movement is, that the eye should follow and distinctly recognize every motion of the forceps, the tooth, and the contiguous parts.

The removal of the roots of these teeth is far more difficult than that of the incisors. Frequently the gum has to be separated up two or three lines on the alveolus, and the latter broken in with the forceps, before the root is removed. The compound screw is often very valuable in the removal of these roots,—the simple screw not commonly being of much avail, since the force necessary to extract the root is generally so great that the screw alone will not take a sufficiently firm hold to accomplish it. The elevator is not a very efficient instrument in the removal of these roots.

Superior Bicuspids.—For the removal of the bicuspid teeth of both sides, one pair of forceps is quite sufficient. (See Fig. 99.) These forceps are without any curve; though in a small mouth, for the second bicuspids, a slight anterior curve would be desirable, since it would admit the instrument to a better position on the tooth. These forceps properly adjusted on the tooth, according to the directions already given, the attachment is broken up by an inward and outward movement, carried just to the extent necessary to accomplish the object; and then traction is applied to remove the tooth from the socket. This application of the force is specially adapted to the first bicuspids. Rotary motion should be very seldom applied to these teeth, because their points generally

terminate in a bifurcation, and it is impracticable thus to detach them without breaking off at least one of the roots; and where they do not bifurcate, they are so much compressed as generally to forbid such a force. Occasionally, however, there is but one root, and this is nearly cylindrical, as will be indicated by the cylindrical form of the crown and neck of the tooth; and in such cases the rotary may be combined with the inward and outward motion. The root of the second bicuspid commonly has no bifurcation, and is usually somewhat compressed; and, in general, the rotary motion may be combined with the inward and outward in its extraction. There is occasionally, however, some curvature to the roots of these teeth; but very seldom is it sufficient to cause any difficulty in their removal. The skillful and experienced operator will in most cases determine very accurately the size, shape, and position of the roots by the peculiarities of the crown; and the attention of the young practitioner should be directed very closely to this point, till he is able to arrive at accurate conclusions. For the removal of these teeth, there are forceps with thick, peculiarly-formed beaks, constructed to take advantage of the conical shape of the roots. The instrument is placed on the tooth at the border of the alveolus, or, if need be, a little beyond it; and then, the process having been first cut away, firm compres-

sion is made on the handle of the instrument, and thus great pressure on two sides of the root,—which are relatively as two inclined planes,—by which the tooth is forced directly from its socket, without either the oscillating or the rotary motion. This instrument is rarely ever applicable to the removal of any other teeth than the second bicuspids, and occasionally the central incisors, and then only when the roots are very tapering. The roots of the bicuspids, especially the second, are usually not difficult to remove. Sometimes, however, the first bicuspids have two well-formed roots, somewhat divergent, that are difficult to remove, especially if the decay has eaten away till there is little of the tooth left for the instrument to take hold upon. But, frequently, if one of the contiguous teeth is absent, a lateral seizure will remove the root at once.

Root forceps with narrow, thin beaks, which may be readily forced between the root and the alveolus, are very valuable for the extraction of all small roots.

The screw, whether simple or compound, is not applicable to the extraction of the roots of the bicuspids.

A bicuspid will sometimes stand somewhat out of the true circle, and the contiguous teeth approximate so that it will not pass between them. In such a

case, the principal part of the movement for its detachment should be in the direction of its inclination. The cuspid teeth are sometimes found in the same condition, and a similar application of force for their removal is to be made; indeed, this method is appropriate to all cases where the teeth stand out of a proper position, and the contiguous teeth impinge on the space.

Superior Molars.—The first and the second superior molars have each three roots, one palatal, and two buccal; the palatal being the largest and longest, and the anterior buccal larger than the posterior. The palatal root diverges very considerably from the axis of the tooth, while the buccal are often parallel with it and with each other; but they sometimes diverge in both directions. Occasionally, the divergence of some or all of these roots is so great, that they cannot pass out of the socket without either fracturing the alveolus or breaking off one or more of the roots. On the contrary, there is sometimes such a convergence of the buccal roots, that the intervening portion of bone is necessarily brought away with the tooth. Indeed, the three roots are sometimes found all in contact, forming an irregular conical root; but this is a condition of unnatural development.

The appropriate forceps being firmly fixed on the tooth, an outward and inward movement is applied,

and traction at the same time. In the examination of these teeth, to ascertain the force necessary for their removal, two particulars have to be considered: the firmness of the attachment, and the position and inclination of the roots. When these teeth, as they occasionally do, stand somewhat outside of the correct position, great care must be exercised in their removal, especially if the contiguous teeth impinge. In small mouths, the contiguous impinging tooth is liable to be injured by the pressure in extraction; but this injury may be avoided by directing the pressure backward. Commonly, the first effort made to break up the attachment should be outward, except where the tooth stands inside the circle, or where it is decayed very much on its inner side, while its outer remains firm. In those cases in which the roots diverge so much that they will not pass out of the socket without tearing away some of the wall of the alveolus, it would be impossible to break up the attachment by an inward movement, for the palatal root braces the tooth, and the inner process is very strong and unyielding. Where a molar has decayed on its proximal sides, and the contiguous teeth encroach on it, so that it cannot pass out directly between them, it must either be cut away with the chisel, file or disk till it is small enough to pass out, or be drawn from between them.

The decay on the buccal or palatal sides often extends below the gum, and even below the border of the alveolus; or there may be extensive softening of the dentine of the crown; in either case, the gum and process must be cut away sufficiently to admit a firm hold on the root where it is strong enough to sustain the embrace of the forceps.

Extraction of Roots.—The extraction of the roots of the superior molars is not attended with much difficulty when they are separated by decay, or are easily broken apart; the method then is the same as for single roots. They should be deeply embraced with the curved, sharp-pointed root forceps (see Fig. 104), and rotated to break up the attachment, traction being applied at the same time. It is very rarely necessary to resort either to the elevator or to the screw for the removal of these roots. The greatest difficulty is experienced when the bifurcation is deep and the roots all adhere firmly together. In such case, the same force is required for their removal as before the crown was decayed off. The root forceps, shown in Fig. 101, can be very effectively used in the extraction of these roots. The round, sharp beak is passed between the buccal roots, the other beak embracing the palatal; and with this hold, by an inward and outward movement, the root is removed. These forceps are not applicable where

there is but one large conical root. For the removal of roots of this form, the wisdom-tooth forceps, or those with similar beaks, are required. When it is necessary to dissect off the gum, and cut away the process, in order to obtain a firm hold of the root, this should be done in preference to crushing in the process with forceps—except, indeed, it may be the case of a very irritable patient, who will not tolerate a protracted operation, in which case it is better to complete the operation at a single effort.

Third Molars.—There is not usually much difficulty attending the extraction of these teeth. The appropriate forceps for this purpose (see Figs. 102 and 107) have two large single-concave beaks, so formed as to embrace the neck of the tooth, without any reference to the bifurcation or the number and position of the roots. Ordinarily, the attachment of these teeth is broken up by the inward and outward movement; but where a single, round, conical root is clearly indicated, the rotary movement would be preferable, or the rotary in conjunction with the inward and outward. These teeth sometimes stand out of the true position, more frequently inclining outward, as already suggested in another place; and the direction of the force for their extraction will correspond with this inclination.

Sometimes these teeth are very difficult to extract;

and this difficulty is dependent on the following circumstances: first, an anterior inclination of the tooth, so that it stands at a considerable angle with the adjoining tooth, and in contact with its posterior proximal surface, the posterior border of the process being thick and firm, and extending down full on the crown of the tooth; and second, the existence of several roots, with great divergence, irregularity, and curvature. The removal of a tooth in the first of these conditions is often a very protracted operation, fraught with much pain to the patient and considerable labor to the operator. Such preparation must be made as will permit a free egress of the tooth from the socket, before an effort is made for its extraction. This is effected either by cutting away the portion of process behind the tooth, so that it may be forced backward sufficiently to let it pass out of the socket, or by cutting away enough from the anterior portion of the tooth; or, if the posterior proximal surface of the second molar is decayed, it may be quite as well, and more convenient, to cut this down so as to permit the ready removal of the tooth.

Physic's forceps can be used very effectively for the extraction of these teeth when they occupy such a position, provided the root is straight, or has a posterior curvature; but if there is an anterior curvature,

the tooth is most difficult to extract, and Physic's forceps would be wholly inefficient, except to break off the tooth. In such case, the posterior portion of the process should be cut away as much as possible. Physic's forceps are frequently employed for the removal of these teeth when they occupy a correct position; but their use is somewhat objectionable, especially in the following respects. The instrument acts first on the principle of a wedge, being forced between the teeth; and then on that of a lever, the second molar being the fulcrum; and hence, when it is employed, the second molar must always be present, and is liable to injury from the pressure, which may do violence to the periosteum, or fracture and scale off portions of the enamel. But if the first molar is absent, there is almost as much liability, with the Physic's forceps, of loosening the second as of extracting the third. Indeed, it is always objectionable to use a sound tooth, under any circumstances, as a fulcrum for an extracting instrument.

A wisdom-tooth the roots of which are irregular in number, inclination, and curvature, should be grasped firmly, and an oscillating force applied sufficient to remove it from its socket. There is nothing pertaining to the removal of the roots of these teeth that involves any different principle or application of instruments from that given for the removal of the

teeth themselves. The anterior inclination, which so often renders the whole tooth difficult of extraction, very seldom affects the removal of the roots. These are, in general, easily extracted with the common curved root-forceps.

Inferior Incisors.—In the extraction of these teeth, either of the forceps described for the purpose may be employed. The beaks should be quite narrow and thin (see Fig. 103). The instrument well fixed on the tooth, the attachment is broken up by an inward and outward movement, the rotary being seldom applicable, since, in general, the roots are flattened, and in many cases quite thin, so as to be incapable of turning in the socket. Care must be exercised in the oscillating movement, and especially where the tooth to be extracted stands out of the proper position, and the contiguous teeth incline together; though this is of little consequence where the teeth are all to be removed. When the crowns of these teeth are short and thick, the roots are shorter, thicker, more conical, and more nearly cylindrical; and in the extraction of such the rotary may be combined with the oscillating movement.

There is seldom any superadded difficulty in the removal of the roots of these teeth, the same instruments and movements being applicable as for the removal of the teeth themselves. The only dif-

ference in any respect is, that where the teeth are decayed off far down, the forceps should be forced down on the process, in order to obtain a firm hold on the root. Neither the elevator nor the screw is ever required for the removal of these roots.

Inferior Cuspids.—These teeth may be removed with the inferior bicuspid forceps of the right side, though an instrument of the same general form, but of less curvature, would be preferable, since with such the required movement for breaking up the attachment could be more easily given. They commonly have long, round, conical roots, not so large as those of the superior cuspids, nor so difficult to extract, seldom having any curvature, and thus being susceptible of detachment by the rotary motion. They often stand so much anterior to the true circle, that an attempt to thrust them inward would be liable to break or loosen the lateral incisors. Their situation, as indeed that of all teeth, should be strictly attended to before any attempt is made to remove them.

The crowns of these teeth decay off, and leave the roots standing, far more frequently than do those of the superior bicuspids. But there is no difficulty in the removal of their roots, and the only indication is, when they are deeply decayed, to pass the forceps far down on them, either first cutting away the process

or embracing it, as the circumstances may warrant, the former method being preferable. After the root is extracted, the fractured pieces of process, if any, should be removed.

A long, tapering screw may sometimes be advantageously used for the extraction of these roots, when they are decayed so deeply that an extensive breaking away of the process would be incident to their removal with the forceps. The elevator, however, is rarely ever called into requisition here.

Inferior Bicuspids.—These teeth, two in number on each side, have but one root each, and that generally round, or nearly so, and not so long as that of the cuspids, and have less diameter at the neck than they. They require, in extraction, forceps for each side, as already described (see Fig. 105). They may be removed either by the rotary or by the inward and outward movement, or both combined. With the handle of the forceps thrown very far out of a line with the axis of the tooth, it is always more difficult to be rotated accurately in its socket; a straight instrument is best for the rotary motion. In the removal of these teeth from the right side, when the mouth is small, care should be taken that too much pressure is not made against the anterior tooth. This accident is more liable to happen in the removal of the second bicus-

pid than in that of the first, and especially if the mouth cannot be opened wide. As the tooth comes out, the forceps are liable, without some attention, to strike the superior teeth, and in this way fracture them or scale off their enamel. In many cases, forceps with a forward and an outward curvature combined would be very desirable, for facility of approaching the tooth; but with such a complication of curves, the operator loses control of the instrument.

In the removal of the bicuspids of the left side, there is little or no liability to undue pressure against the anterior teeth; and in their extraction the movement should be mainly inward and outward, since the great curvature of the forceps renders a rotary motion very difficult and uncertain. There is also danger of striking the upper teeth, especially if the tooth to be extracted comes out with less effort than the operator anticipated—an accident that sometimes befalls the most skillful and discriminating. The first and the second inferior bicuspids are removed with about equal facility.

Occasionally, though seldom, these teeth have two distinct, well-defined roots—a condition that cannot be determined by the form of the crown, or by any other visible indication; and one tooth alone will sometimes be found with this peculiarity. The re-

moval of the roots of these teeth is not attended with much difficulty, the main consideration being to obtain a deep, strong hold on them, and then apply a firm, steady movement.

Inferior Molars.—These teeth commonly have two roots, a posterior and an anterior, the latter being the largest, and frequently the longest. The roots have different inclinations to the axis of the tooth, being in some cases divergent from, and in others parallel with it, and in others convergent, or curved together so that their points almost meet. The forms of the crowns will give some indication of the inclinations of the roots. If the former are short, the latter are so, and *vice versa;* if the diameter of the crown is about the same at the masticatory surface and the neck, the roots do not diverge; if the crown is long, and of uniform diameter, the roots will be either parallel or convergent; and if the angles on the crown are not sharp and well defined, the roots most probably curve together at the points. If, however, the angles formed by the masticatory and lateral surfaces of the teeth are sharp and well defined, the roots generally diverge.

Forceps adapted to each side are required for the removal of these teeth. These forceps have a prominence, or point, in the centre of the beaks, to pass into the bifurcation; and in separating the gum, it is important to dissect it away, and, if need be, even

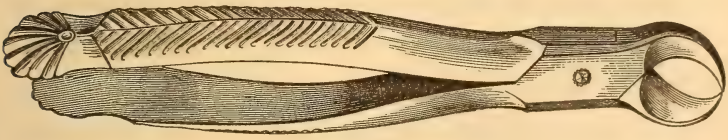
cut away the margin of the process, so that the bifurcation may be well exposed, to admit the forceps to a proper position on the tooth, without obstruction. The tooth being firmly grasped in the proper manner by the forceps, is moved gradually, but steadily, inward and outward, to break up the attachment, and then drawn from its socket. In the removal of these teeth from the right side with the ordinary forceps, there is great danger of undue pressure on the anterior contiguous teeth; this is to be avoided by directing the pressure backward in the operation. And there is also danger of injuring the upper teeth with the forceps; this may be obviated by wrapping the point of the instrument with a small napkin.

In the removal of the inferior molars of the left side, the application of force is the same—an inward and outward movement—but the handles of the forceps occupy different relative positions to the teeth to be extracted—passing directly out at the front of the mouth instead of at one side. In consequence of this arrangement, the operator cannot exert the same force on them as, with the proper forceps, on those of the right side. Very little traction can be employed in connection with the oscillating movement, but the attachment must be almost wholly broken up before beginning to lift the tooth from the socket. But in extracting the teeth on the right

side with the proper forceps, traction is always combined with the inward and outward movement.

In the extraction of the roots of these teeth, little difficulty is experienced after the decay has proceeded so far as to effect their separation. They are then embraced with the appropriate forceps, and removed as single roots are elsewhere. These forceps have narrow, thin, sharp beaks, turned to almost a right angle. With them the root is embraced and moved inward and outward till loosened, and then removed. When the mouth is large, and can be opened wide, the slightly curved root forceps are convenient, and the rotary movement may be employed with them, if the roots are not very much curved, flattened, or firmly set. The removal of these roots is more difficult when the bifurcation is low down, and the roots remain firmly attached together, and especially when they diverge. If the bifurcation is not too low, and the attachment not too firm, the roots may be separated with the separating forceps (Fig. 122), and

Fig. 122.



then removed singly, as in other cases. This is the preferable method when there is much divergence;

but if the roots cannot be separated, they may be extracted with the forceps shown in Fig. 122. The round, curved, sharp beaks are passed down between the roots, and the whole is removed at once; the attachment being broken up on the principle already described.

These teeth sometimes have but one large, round, conical root; and there is seldom, if ever, enough curvature of the roots to render extraction difficult. The ordinary inferior-molar forceps are not well adapted for the purpose, for the central points of their beaks will prevent a perfect adaptation. The broad, single-concave beaked forceps are best adapted, the curves and general forms of which, except the beaks, are the same as those represented in Fig. 107. The removal of teeth having roots of this kind is easily accomplished. Rotary movement would be applicable here if the exact form of the root could be ascertained before extraction; but it is, in general, the safest course to employ the inward and outward movement.

Inferior Third Molars.—These teeth require for their removal the broad, single-concave beaked forceps, the beaks curved at a right angle with the handle, and the handle straight. This instrument fixed deeply and firmly on the tooth, the attachment is to be broken up by the inward and outward movement. These, more frequently than the superior

third molars, stand out of the proper position; their variations and the manner of obviating the attendant difficulties, however, being about the same—at least, so far as deviation is concerned. Physic's forceps may be used here with greater facility than on the upper teeth.

These teeth frequently exhibit but a very small portion of the crown through the gum. Being erupted with an anterior inclination, the tooth comes in contact with the posterior portion of the second molar, and is thus checked in its external development. Thus the crown is left partially covered with the gum, which frequently inflames, and even suppurates, remaining in that condition for a considerable time, to the great annoyance of the patient. Such teeth are difficult to remove; first, because of their inclination and contact with the second molar; and secondly, because the crown is more than half below the borders of the thick, firm alveolus, rendering it impossible to obtain a firm hold of the tooth without cutting away a portion of the alveolus. In such cases, it is generally best to make a free excision of the alveolus all round the tooth, sufficient to permit its easy removal.

EXTRACTION PREPARATORY TO THE INSERTION OF ARTIFICIAL DENTURES.

Whenever there is a number of teeth to be removed, the method and the duration of the operation will depend on the following circumstances:

First. The number to be removed.

Second. The firmness of their attachment.

Third. The patient's power of endurance.

Fourth. The manner in which the immediate parts are affected.

Where the number to be removed is considerable, and the attachment feeble, or not very firm, and the patient's power of endurance good, the extraction may be as rapid as is consistent with efficiency. In many such cases, from three to six teeth may be removed, without any relaxation by the operator of his hold on the parts with the left hand. This is generally practicable with the front teeth of the lower, and frequently with those of the upper jaw; but it is not proper to remove more than three or four of the molar teeth without respite, even when they are quite loose, or have but a feeble attachment in the socket. The gum should of course be well separated previously to the operation. Only so many teeth should be removed at one sitting as the nervous

system will allow without too great a shock. In many instances, however, it is practicable, so far as this is concerned, to remove at once all the teeth in the mouth. In the extraction of a large number, those most easily removed should be first taken, so as by degrees to bring the patient to the more severe operations. If there is a manifest hemorrhagic diathesis—a disposition to bleed freely from the capillaries, as well as from the larger vessels—but two or three teeth should be removed at a sitting, lest uncontrollable hemorrhage ensue.

After all the teeth are removed from one or both of the jaws, the gums and alveolus should undergo a trimming process: all detached, flabby, or prominent portions of the gums should be dissected off; the whole ridge made uniform; all loose portions of the alveolus removed; all the prominent points and sharp edges cut down; and the whole border of the process rendered as smooth and even as possible. By this means, the healing of the parts is facilitated, and they assume the desired condition and form in much less time, and with far less soreness and inconvenience.

CONDITIONS TO BE OBSERVED IN EXTRACTION.

Such conditions are often found to exist in the system as indicate the necessity of great care in the

operation, or of prior treatment, or forbid the extraction of the teeth altogether. Of these conditions, the following are some of the more obvious:

Extreme debility.

Great nervous irritability.

Excessive local inflammation, especially where it tends to other parts.

Much irritability of the parts intimately connected with the teeth.

Pregnancy and all uterine irritations.

A tendency to epilepsy.

In many cases, where there is great debility, so painful an operation as the extraction of a tooth will cause extreme and sometimes alarming prostration. This, however, may be anticipated by prior invigorating treatment, continued till strength and tone are obtained sufficient to endure the operation. This treatment may occupy considerable time, while an urgent case may arise, in which the removal of the offending tooth is immediately demanded, in which case it is proper to administer stimulants—brandy or wine, or such as the case may seem to require. By such means the system may be so invigorated as to withstand the shock of the operation with comparative fortitude.

There is in some cases a highly irritable condition of the nervous system, that almost absolutely forbids

the extraction of teeth, convulsions being sometimes produced in such cases by a simple operation. This remark does not of course apply to facial neuralgia, that may be either partially or wholly produced and kept up by diseased teeth; neither general nor local neuralgia would be aggravated by an operation of this kind. Accompanying general nervous irritability, there is usually excessive dread of an operation, such as to occasion rapid prostration—even greater and more rapid than that caused by the operation itself. In such cases, if the extraction is effected immediately, it will give relief; but where the excitement has been very high, and the tension for some time great, the depression after the operation will be correspondingly great, and considerable time be required for complete recovery; indeed, the shock is sometimes so severe as to occasion confinement for several days. Treatment for quieting the nervous system, consisting in agents of a sedative character, may be employed previously to the operation. Stimulants, as a general rule, should be avoided.

Where there is a high state of inflammation in the immediate parts, especially if there is a general inflammatory diathesis, the propriety of extracting the teeth is questionable. Under such circumstances, there is probably less danger in the extraction of the inferior teeth than of the superior. Where the inflam-

mation has a disposition to extend, it is liable to go to the head from the superior maxilla, and to the fauces and throat from the inferior. In cases, then, where there is excessive inflammation in the immediate parts, accompanied by a general inflammatory condition, both local and general antiphlogistic treatment should be adopted.

Extreme irritability, or a diseased condition of parts having an intimate connection with the teeth, as, the immediate surrounding tissues, the salivary glands, and the throat, is a circumstance admonishing to great caution in the extraction of teeth, especially when such condition does not depend on the teeth for its exciting cause or modifying influence. It is, however, very generally the case, when any of the parts having an intimate relation with the teeth become in any way affected, that diseased teeth will exercise an injurious influence on them. If the necessity for the removal of the offending tooth is not too urgent, the parts that may be diseased about it should be brought to as good a condition as possible.

Pregnancy and uterine irritation frequently produce strong sympathetic influences on the teeth, and especially on those which are in an irritable condition. Even sound teeth may be thus affected, so as to occasion great annoyance. Such teeth are frequently presented for extraction; but these cases should always

be thoroughly examined before deciding as to the propriety of an operation. As a consequence of this sympathetic connection between the teeth and the uterus, the latter, when in an irritable condition, is very liable to be affected by any special violence to the former. In many cases, under such circumstances, the extraction of a tooth is attended with pain in the uterus; and in cases of pregnancy, where there is debility of the parts involved, abortion may follow the operation. It is the duty of the patient, under such circumstances, to notify the operator of the condition, or if the latter has any knowledge of it, it is his duty to become fully acquainted with the circumstances, and then to conform to the indications. In such case, treatment will avail but little to prepare the system for the operation. The better method is to adopt palliative treatment, which, if the affection is wholly sympathetic, must be directed to the organ producing the difficulty. But if the affection is in part local, then topical treatment is also indicated. When there is a suppression of menstruation, there will be an increased disposition to hemorrhage; and in the extraction of the teeth of a patient of hemorrhagic diathesis, this is a point to which attention should be very specially directed. Here, of course, a remedy for the obstruction would meet the difficulty.

Persons subject to epilepsy should be very cau-

tiously treated in all operations on the teeth, and most especially in their extraction. It is not probable, however, that an operation of this character would increase the tendency to epilepsy; but any undue excitement is liable to produce a paroxysm of the disease, and hence the operator should proceed to his work with as little parade as possible, yet not stealthily; the patient should be thoroughly aware of what is to be done; for, of all patients, such a one is the last that should be deceived. Of course, in a case of this kind, there can be no prior treatment that will avail anything; the most that can be done is, to await the fittest opportunity in respect to the paroxysms. There is no more liability to fatal results with such patients than with others.

CHAPTER XII.

ACCIDENTS IN THE EXTRACTION OF TEETH.

The accidents liable to occur to the teeth and the contiguous parts in the operation of extraction were formerly far more frequent than at present. This results from the existence of more perfect instruments and of more accurate and extensive knowledge. Formerly, very few studied the peculiarities of the teeth, either in their physical or anatomical structure; their peculiar forms, as indicated by their crowns; their anatomical and physiological relations to the contiguous parts and to one another; and their attachment as affected by the character and structure of the tissues about them. The instruments employed, too, were, till within a few years past, very crude in their forms, very inapplicable in that part which embraces the tooth, inappropriate in their shapes, and defective in their manner of applying the force in the operation. But these causes of accidents, so far as the better part of the dental profession is concerned, have been in a very marked degree diminished.

Some of the accidents attendant or consequent on the extraction of teeth are of a grave character. Permanent deformity has sometimes been occasioned by extensive laceration of the soft parts, or by fracture of the alveolus and of the maxilla. Intense and protracted suffering frequently, and death sometimes, follows such accidents.

HEMORRHAGE.

Excessive and obstinate hemorrhage in some cases follows the extraction of teeth, occasionally resulting seriously and even fatally. There is in some constitutions a hemorrhagic diathesis, so that from a small wound, or even a scratch, there will ensue persistent bleeding. This condition is dependent, first, on a lack of tone in the blood-vessels, so that they fail to contract at an injured or ruptured point; and secondly, on a peculiar condition of the blood, such as to prevent ready coagulation, as when there is a relative deficiency of albumin and fibrin. It is one of the most important duties that ever devolve on the dentist, to make a correct diagnosis in cases where there is a tendency to hemorrhage. Close attention to the following points will assist much in arriving at a just conclusion. In persons of a hemorrhagic tendency, there is a lymphatic, serous temperament; a lack of

tone in the soft parts—a soft, flabby condition; the skin pale, and devoid of the bright, vital appearance; the eyes and hair of light color; and the flow of saliva and mucus abundant. Besides these indications, much may be learned sometimes by properly directed inquiries of the patient in regard to a disposition to hemorrhage on being wounded, either in his own case or in that of his relatives; if in the former, under what circumstances; whether from an extensive or slight wound; from large or small vessels—from arteries or veins; or whether it occurred immediately or after the lapse of some time. If the patient has never met with an accident sufficient to occasion excessive hemorrhage, and any of his relatives have, and a tendency to bleeding is suspected in the case, the operator should ascertain whether there is a similarity of temperament and constitutional tendencies between the patient and such relative.

There are certain conditions in which excessive hemorrhage would be more likely to occur than in others; as, for instance, when there is an accidental relaxation, or deficient tone in the system, especially the vascular; and also when there is a suppression of any periodical discharges. There may be excessive hemorrhage from a ruptured vessel when there is no constitutional hemorrhagic tendency. There is

sometimes a local difficulty with the vessels—a lack of tone in the part—or an aneurismal condition—on account of which obstinate hemorrhage will occur. A peculiarity of this kind is not very readily recognized.

Violent passion, and, indeed, any strong agitation of the mind, will aggravate hemorrhage. Improper medication, as well as highly stimulating food, will have the same tendency. Anything that will increase the circulation, or reduce the tone of the vessels, or change the condition of the blood, will increase the liability to hemorrhage. Simple determination of blood to a part, however, would not indicate such a liability. When there is a special hemorrhagic diathesis, the blood will flow from all the wounded surface, will be thrown out from all the ruptured capillaries. The most difficult cases are those in which there is a defect both in the vessels and in the blood. If the latter is in a good condition, it will coagulate in ruptured capillaries, though they might be deficient in tone; but in larger vessels, though coagulum might be formed, it would hardly be retained.

TREATMENT.

In cases where there is manifest hemorrhagic diathesis, prior treatment is indicated, if the necessity

of extraction is not urgent; and that treatment will be determined by the peculiar condition of the case. If there is a lack of tone in the vessels—an inability to contract—then the treatment should be of a tonic character; and if the blood is in good condition, this is the only treatment necessary; but, if in a vitiated state, other treatment will be demanded, the object of which is to produce an increase of red corpuscles, albumin and fibrin. It is always better to postpone an operation, if at all practicable, till such treatment can be had as will bring the system to the best possible condition.

Of the several methods of arresting hemorrhage, the proper one in a given case will be determined by the circumstances. Styptics or astringents applied directly to the ruptured surface will often be found to produce coagulation of the blood, and thus stop its flow without anything else. This kind of remedy will be efficient in those cases in which the application will produce contraction of the bleeding vessels, as well as coagulation of the blood. Sometimes this class of agents will fail to accomplish the object; in which case, in addition to them, compression should be made upon the part. Indeed, in many cases, the compress will effect all that is desired, without any other application.

There are several methods of applying the com-

press; but the one best adapted to any given case will be determined by circumstances—such as the extent of the wound, the character of the hemorrhage, the location of the injury, and the size of the mouth.

A very common method of making compression in the socket from which a tooth has been drawn, is to force into the cavity pledgets of cotton, or small strips of linen, tightly till it is full. It is well to saturate these with a solution of tannin, or some astringent preparation, applying it, too, in connection with the compression. In some cases, a simple packing of the cavity in this manner is quite sufficient; but in others it is necessary to retain the pledgets in the socket by means of further compression. This is effected by placing a roll of linen, or perhaps better, a properly-formed piece of cork, on the packing, and then closing the jaws tightly upon this, and, if need be, placing a bandage under the chin, and tying it firmly over the head. The length of time during which it will be necessary to keep the jaws thus together will, depending on the nature of the case, be from one to six hours. After the hemorrhage has entirely ceased, the bandage is to be removed carefully, and the patient instructed to hold the jaws together on the compress for a time, and then gradually to open the mouth, and remove the cork with

much caution. After this the packing should remain in the socket from one to three days, and then be removed very carefully, one piece at a time, lest the ruptured vessels be opened and the hemorrhage caused to recur.

The object in applying a compress is to bring it to bear upon the aperture of the wounded vessel, and in this way to prevent the escape of blood, till coagulum is formed and the opening permanently closed. The operator should ascertain the precise point from which the blood flows, and form the compress so as to bear full upon it. If the flow is from all the wounded surface, then the compress must be made to conform exactly to that throughout.

Another method of making the compression, is to force softened wax into the socket, so as to fit it perfectly; remove it and chill it in cold water; and then introduce and make compression upon it in the manner already described, following throughout the general directions. Another, and probably better, method is to form cones of wax cloth, as near the shape and size of the root removed from the socket as possible. This material is prepared by dipping thin linen into melted beeswax, withdrawing it and letting it cool, and then cutting off strips of from a fourth to half an inch wide, and rolling them to the proper size and shape; having softened this material

by heat, and freed the socket of coagulum, introduce and press it firmly into place, making the compression on it as already directed. This makes a very efficient compress for many cases.

Plaster of Paris is sometimes used on the principle of a compress. Having the plaster mixed of the proper consistence, and the cavity clear, fill completely with it, let it set, and then make compression on it in the usual manner.

The root of the tooth is sometimes returned to the socket, to serve as a compress. It possesses the advantage of having a perfect adaptation. This method of compression may be made more thorough by immersing the root in melted wax, and then, before this becomes too hard, introducing it into its original position. This makes a very perfect and efficient compress. If the crown is still remaining, when the jaws are closed it will come in contact with the opposing teeth, and thus be kept firmly in place, without anything further. It may be removed carefully after from one to three days. In cases where there is hemorrhage from the entire wounded surface, there will be a considerable flow of blood from the margin of the gum, even after plugging up the socket, and making compression by either of the methods described. In such case, after the socket is plugged up as already described, a plate is so formed as to fit

tightly over the gum, and draw its margin down closely upon the compress. This pressure on the bleeding edges of the gum checks the flow of blood there. The plate must be held down by the means already described. It is sometimes difficult to obtain an accurate fit for the plate, so as entirely to prevent the blood from continuing to ooze out. In such cases, make the plate to conform as nearly as convenient to the part; then fill up its concavity with plaster of Paris, mixed to a proper consistence, and then place the whole upon the part, till the plaster conforms exactly to it, and retain it there till the plaster sets. This is then used for the compress. Or the inside of the plate may be thickly coated with softened gutta-percha, instead of plaster, and pressed upon the part in the manner already described, and employed in the same way.

It will often require considerable discrimination to determine the best method of obtaining compression. Very great difficulty is occasionally experienced when a portion of the process has been broken away, or the soft parts have been lacerated.

Various preparations are used as hemostatics. These agents serve to check hemorrhage in two ways: first, by facilitating coagulation of the blood; and, secondly, by producing a contraction of the orifice of the ruptured vessels. It is proper in all cases

to use styptics in connection with the compress. The following agents have been used as styptics: tannic acid, creosote, nitrate of silver, chloride of zinc, sulphate of zinc, oil of turpentine, muriate of iron. The methods of applying these different preparations are the same. The agent is simply to be retained in contact with the part till it has exerted its influence. A solution of tannin in alcohol, with creosote, equal parts, makes a very powerful styptic; or tannin and creosote alone is perhaps equally efficient.

The actual cautery is sometimes used to arrest hemorrhage; but the propriety of using it in cases where there is a manifest hemorrhagic diathesis is exceedingly doubtful. When the cauterized surface is sloughed off, the hemorrhage is liable to recur with increased vigor, indeed, is certain to do so in almost every case where there is a strong predisposition. Constitutional treatment may be employed to anticipate hemorrhage; and it should have in view an increase of the relative amount of red corpuscles, albumen, and fibrin in the blood, and also the production of a normal tone of the system. Saline purgatives may be used with very decided advantage, followed with acetate of lead, in connection with opium, the effect of the lead being to increase the coagulability of the albumen and fibrin. Care should be exercised, however, in its administration.

Excessive hemorrhage will sometimes occur from very slight wounds; death has been known to ensue from simply scarifying the gums.

Mr. C. desired the removal of the first superior molar. The gum was separated from the neck of the tooth with the lancet, in the usual manner, when he refused to have anything further done, and left the office, there being a slight discharge of blood from the gum. After a few hours, the hemorrhage increased, so as to cause alarm to his friends. The patient was about eight miles from a dentist, and a physician of rather moderate skill was called to the case. He probably acted according to his best knowledge, but failed to arrest the hemorrhage, and succeeded in convincing the friends that no one else could do better. The flow of blood continued three to four days, proving well-nigh fatal, but at last abated, and the patient recovered. In this case, a properly-directed compress would have checked the bleeding in a few minutes.

Another case: Mrs. T. had nine teeth removed. The operation was not followed immediately by unusual hemorrhage, but within two or three hours the flow of blood had increased to an alarming extent, so as to run from the mouth in a continuous stream. The indications were that the patient would soon die. She had become very weak. On examination, the

blood was found issuing only from the socket of one root of an inferior molar. The mouth and socket being cleansed of blood and coagulum, it was perceived that the hemorrhage was from a small artery at the bottom of the socket, spouting out in jets with the pulsations. The treatment consisted in rolling up pledgets of cotton very tightly, saturating them with creosote and tannin, and forcing them in on the bottom of the socket, so as to make compression upon the bleeding vessel. The socket was then filled up, compression made, and the head bandaged in the manner already described. Thus the hemorrhage was immediately checked, and did not return. The constitution of this patient was of a scorbutic diathesis.

Excessive bleeding often does not occur till a considerable time after an operation; and it may come on without any exciting cause, or be induced by vigorous muscular exercise, or by any intense mental excitement. Everything of this kind should be avoided where there is a predisposition to hemorrhage, and everything invited that would tend to maintain the equilibrium of the circulation and the utmost quiet.

FRACTURE OE THE ALVEOLUS.

The ordinary fracture of the alveolus is a matter of no considerable consequence, if it receives proper attention. This fracture occurs to a greater or less extent under the following circumstances:

First. When there is great divergence of the roots, so that the tooth cannot pass from its socket, unless one or more of them are broken off, or the alveolus is fractured.

Second. Where the tooth is forced out of the socket at a very considerable angle with its axis.

Third. Where the alveolus is very firmly attached to the roots, and is very thin toward the point of these.

Usually, the fracture is of that part which forms the socket of the tooth removed; and when this is the case, it is of but small moment. It sometimes, however, extends far beyond this, involving the alveolus of from one to four of the adjacent teeth, and causing very serious injury, even the loss of the teeth themselves. Extensive fracture, however, is far less liable to occur now than when less perfect instruments were employed. When the key was in general use, extensive fracture of the alveolus was frequent; but with the forceps, it is comparatively rare.

When an accident of this kind does occur, all of

the detached portion, whether large or small, should be removed. A pair of bone nippers, or enucleating forceps, will answer for this purpose. If there is much attachment of the soft parts, it should be dissected off, and then removed. If such fractured portions are permitted to remain, inflammation, and oftentimes sloughing of the gums, will ensue; necrosis of the bone is also sometimes produced by detached bone remaining in contact with the living.

Sometimes extensive fracture occurs, involving the adjacent bony structure. In the case of Mr. W., in an effort to remove the first superior molar, the outer wall of the alveolus was separated from the other teeth. The fracture extended almost to the zygomatic process, and detached a portion of the floor of the antrum, as well as a part of its outer wall. After the removal of this detached portion, there was a considerable external depression, that very much marred the form and symmetry of the face.

Fracture of the alveolus should always be guarded against as carefully as possible. It always makes an unfavorable impression on the mind of the patient, which in many cases no explanation can obliterate. Whenever the accident does occur, the disagreeable knowledge of it may, if practicable, remain a secret with the operator.

LACERATION OF THE GUMS.

The gums are often bruised and lacerated with the key in the extraction of teeth. But this accident seldom happens with the forceps; indeed, never, unless the gum is very firmly attached to the neck of the tooth, and has not been separated with the lancet. The gum will sometimes be lacerated by adhering to a piece of the process while the tooth is drawn from its socket, with the process and gum attached. With the various hooks and punches, the gums, lips, and cheeks are sometimes wounded. Accidents of this kind are to be prevented by placing a finger of the left hand, or a guard made of a roll of linen, in front of the instrument. When any considerable portion of gum is lacerated, the detached portion should be cut off. The worst consequences from laceration of the soft parts occur where there is a hemorrhagic diathesis. The most effectual means of preventing accidents of this kind is to separate the gum perfectly, and guard well the points of the instrument.

BREAKING THE TEETH.

This is an accident of no small consequence, and is liable frequently to occur in the use of imperfect, illy-

adapted instruments, or in the unskillful use of good ones. It is of very common occurrence when the key is employed for extracting, even in the hands of those who claim to be skilled in its use. And with forceps, too, of the primitive form, the teeth were so frequently broken, as almost to preclude their use as extracting instruments. This accident usually occasions great pain to the patient, as well as protracts the operation, and diminishes his confidence in the ability of the operator. One such accident will create more prejudice than fifty skillful operations can obliterate.

In all cases where a tooth is broken, the root, if possible, should be removed; for if it be not, continuous or periodical pain, inflammation, alveolar abscess, and like affections, are liable to ensue. The remark is often made, when teeth are broken, that the gums will close over the roots, and thus effectually protect them, and no disagreeable consequences will follow. In no ordinary case will the gums unite over even the smallest portion of root that may have been left in the socket.

REMOVAL OF A WRONG TOOTH.

There is very rarely any excuse for the removal of a sound, healthy tooth in the immediate vicinity of a

diseased one, unless it be in a case of those deep-seated, hidden affections which are difficult to diagnose. It sometimes happens, however, that a sound tooth is removed; and when a mistake of this kind is made, the diseased tooth should also be at once removed, and then, if the conditions are favorable, the healthy one should be immediately replaced. The circumstances most favorable for such replacement are a good constitution in a state of health, and a normal condition of the mouth, especially of the gums and mucous membrane, so that the attachment would take place with as little inflammation and soreness as possible. If the tooth is necessarily kept out of the mouth many minutes, it should be placed in water at about blood heat; and before the replacement, the socket should be thoroughly cleansed of coagulum. The tooth is then introduced, pressed firmly to place, and allowed to remain, without disturbance or irritation, till the attachment has become complete. During the time it is reuniting, treatment may be required to counteract inflammation. Meagre diet, abstinence from stimulants, and quiet, should always be recommended in the case.

This operation has been wholly condemned by some very good dentists. Dr. Koecker declares that it should never be attempted. But numerous successful cases, well attested, give assurance that it may

very frequently be accomplished with the most satisfactory results. Mr. T., aged fifteen years, of good constitution, and in good health, and with the mouth principally in a normal condition, had the second inferior bicuspid of the left side removed by mistake, the first molar being the offending tooth. The former was at once put into cold water, and the latter forthwith extracted. The socket of the bicuspid was then cleansed, and the tooth replaced. There was slight soreness for a few days, after which the tooth was found to have made a firm and permanent re-attachment, and from that time to this—thirty-three years—it has remained perfect, and is now as healthy, lifelike, and valuable as any other tooth in the mouth.

Since the issue of the first edition of this work, many cases have come under the observation of the writer in which detached teeth have been replaced, and become as firmly fixed in the sockets as before removal, and remained in apparently a healthy condition so far as the attachment is concerned. In some of these cases very unfavorable conditions were present.

So numerous and successful have these cases been, that the feasibility of replacing teeth that have been improperly removed is a matter no longer to be controverted, and especially when favorable conditions exist—good health and tone, both general and local, and the parts involved not too much fractured or lacerated.

DISLOCATION OF THE INFERIOR MAXILLA.

The dislocation of the inferior maxilla is an accident of not very frequent occurrence. In persons of lax muscles and with large mouths, the operation of extracting teeth is liable to produce it—sometimes when the operation is on the upper jaw, but more frequently when it is on the lower. In the former case, it is a result of the patient's effort to open the mouth; but in the latter, generally that of the movement of the jaw by the instrument. The dislocation consists in a downward and forward movement of one or both of the condyles, so that they are thrown out of their sockets, and rest in front of the anterior rim. In such case, the mouth is distended to its utmost, the chin thrown down on the breast, and deglutition and speech rendered impossible. Sometimes but one condyle will be thrown out, in which case the jaw is thrown downward and to one side.

This accident seldom or never occurs with patients who have small mouths or firm muscles. When it does happen, however, the dislocation should be promptly reduced. Of the various methods of accomplishing this reduction, the one most commonly employed, which is very efficient, is as follows: If both condyles are dislocated, place corks or some similar

substance between the superior and the inferior molar teeth of both sides, and then, with the fingers of both hands, make firm, steady pressure on the chin upward and backward, thus forcing the condyles downward and backward into their proper places. If but one condyle is out, the cork should be applied only on that side, and in the manner already directed. Another method is, to substitute the thumbs of the operator for the corks, placing them in the same position between the teeth, and manipulating with the fingers on the chin, as before. The patient should be placed in a recumbent position for the operation. Another method is, to make downward and backward pressure on the coronoid process, and in this manner cause the condyles to glide into their places. This accomplishes the reduction without taking hold of the jaws, or placing a fulcrum between them.

This accident is far more liable to occur the second time in the same case. In extracting the lower molar teeth for a person who has suffered a dislocation, or is predisposed to it, the lower jaw should be very firmly supported with the left hand; or the accident may be prevented by placing a bandage under the chin and over the head, so that the mouth cannot be opened to its furthest extent; and this is the surest method. In all cases after an accident of this kind,

the patient should abstain from solid food for a few days, or at least till the soreness is abated, and avoid everything promotive of inflammation.

SYNCOPE.

Syncope, or fainting, is frequently brought on by extraction of the teeth, and even by other operations upon them; indeed, it is sometimes produced simply by cutting the gums, or by the sight of blood, or, in some instances, by dread of an operation. It consists in an intermission of the heart's action, and consequent irregularity of the circulation, accompanied with a temporary suspension of the functions of the brain, and a loss of consciousness. Difficult or suspended respiration, pallor of the skin, and inability to move, are the external indications of the condition. There are no constitutional appearances known by which a predisposition to syncope can be determined. Persons of all apparent conditions and peculiarities are subject to it. The most strong, robust, and healthy sometimes faint under the most trivial influences, while others, of the weakest and feeblest constitutions, cannot be brought into this condition by any ordinary means; so that nothing can be predicated of appearances as to such predisposition. The fainting may occur once or twice in the same case, even under the most simple operation, owing to

some temporary condition of the system, and never happen again under any circumstances whatever.

It sometimes comes on before, sometimes after, and sometimes during, the operation. There is greater liability to it after a recent meal than after digestion is completed, since the nervous energy during digestion is directed to the stomach and its appendages, and thus the circulatory apparatus has less of nervous force.

The frequent occurrence of syncope indicates a constitutional predisposition to it, and may enable the operator to anticipate it to some extent, by the aid of stimulants, such as brandy, or, what is in some respects preferable, a galvanic current. The patient subject to such affection should be placed, for an operation, as nearly as practicable in a recumbent position,—especially for the extraction of teeth,—and his mind kept as tranquil as possible.

To restore the patient from syncope, place him in a horizontal position, the head quite as low as the body, and apply volatile stimulants to the nostrils, and dash water on the face and chest. All compression should be removed from the body, especially from the chest, as it would constrain the action of the respiratory muscles. This remark is peculiarly applicable to female patients. This treatment will usually be quite sufficient to effect a rapid reaction and resuscitation.

CHAPTER XIII.

ANÆSTHETICS.

ETHER—CHLOROFORM—NITROUS OXIDE.

Sulphuric ether was the first agent successfully employed for producing insensibility to pain during surgical operations. It was brought to the notice of the profession in 1846, by the late Dr. Horace Wells, of Hartford, Conn.

The mode of administering it is by inhalation of the vapor; and it produces its effects in a short time, depending on the quality of the ether, the amount of air introduced with it, and the susceptibility of the patient. A complicated instrument, denominated an inhaler, was first employed for its administration; but it soon became apparent that this was not at all necessary, and that simpler methods were preferable, because more easily regulated and adapted to varying circumstances. The best method is to inhale it from a sponge or napkin, since in this way the admission of the air can be controlled entirely by the will of the operator, graduating it to the requirements of the case.

During the administration, the patient should be in a reclining posture; though it is held, by good authority, that a horizontal position is the safest, because in that the force of the circulation is most nearly equalized. In the administration of general anæsthetics, the circulation is always more or less affected. It is an opinion very generally received, and probably correct, that where there is functional derangement of the heart, lungs, or brain, general anæsthesia should not be employed. This opinion, however, is perhaps derived more from analogy than from actual observation. It is true that, other things being equal, the liability to injury in such case would be greater; but the danger with both ether and chloroform is, that there are cases in which there is an undefinable and undetectable idiosyncrasy, or mal-susceptibility of its influence, to a great extent independent of pathological conditions.

The patient having been placed in a comfortable position, and his mind freed as far as possible from apprehension, he should be directed to breathe tranquilly by full inspirations, carefully guarding against any compression of the chest, so as to allow the respiratory muscles free play. During the administration of the anæsthetic, a strict watch must be maintained over the patient, having reference to the following points: The breathing should be free and

easy, without irritation of the throat or bronchia; the skin should not become blanched, but should retain a florid, lively color; but the great criterion is the pulse, and the indications given here should be strictly observed and obeyed. In order that the operator may follow every indication, he should be familiar with the manifestations of the pulse in different constitutions and under different circumstances. During the administration of ether or chloroform, the pulse usually becomes more frequent; but it should not be much accelerated, nor its strength and fullness be much diminished. Enfeebled or irregular pulse should in all cases be regarded as a warning; and if the feebleness and irregularity be very marked, the operator should desist. In some instances death has occurred after a few inhalations; but perhaps only in the use of chloroform. This fact indicates that the first effects of the administration should be very closely noted.

The degree to which the anæsthesia should be carried is a matter about which there is much diversity of opinion. Every condition of it, from that of simple allayed irritability to that of complete insensibility and unconsciousness, has its advocates. But the extent to which the administration may be carried will be suggested by the indications already referred to, and, if these are unfavorable, should be deter-

mined at once. Mere nausea, however, without any other unfavorable symptom, is not a counter-indication in the use of ether or chloroform.

The method of administering chloroform is the same as that for ether, except that in the use of the former more care and closer observation are required. Chloroform is more rapid and powerful in its action than ether, and hence more liable to do injury; but, independently of this fact, it is generally believed that the former is less safe than the latter, when taken into the system, especially by inhalation. A mixture of ether and chloroform, or chloric ether—usually equal parts of chloroform and ether, but the proportions are sometimes varied—is used by some, the object being to secure greater promptness than with ether alone, and incur less danger than with chloroform; and it is probable that a mutual compensation in these respects is thus to be attained.

If either chloroform or ether has been administered to entire unconsciousness, the patient should be permitted to pass out of the condition spontaneously; for after such a revival there will be less liability to unpleasant feelings, as headache, depression, and nausea. The fingers of the person administering the chloroform should be kept on the carotid, since the state of the circulation will be better recognized by this than by the radial artery, and it is a more con-

venient point for observation. In favorable cases, it is preferable to continue the inhalation till there is muscular relaxation.

When a condition arises in which respiration is suspended, and the circulation partially or altogether stopped—a condition of imminent peril—active measures must be resorted to for the patient's restoration. Efforts must be directed to a recovery of the circulation, by friction, motion, etc.; but to restore the respiration, is the first, immediate, imperative consideration. Any or all of the ordinary methods of re-establishing suspended respiration may be employed. Cold water should be dashed in the face, and on the throat and chest, and volatile stimulants applied to the nostrils; the glottis should be titillated with a feather, or some such implement, to excite it to action; and artificial respiration, by some approved method, should be at once adopted. The galvanic current, too, may be brought into requisition, to excite the respiratory muscles to action, and to act also upon the circulation. In all cases of accident of this kind, prompt and efficient measures should be immediately taken, for a delay of a few moments may be attended with fatal results.

NITROUS OXIDE.

Nitrous oxide is now used as a general anæsthetic quite extensively in dental practice. This agent, when properly prepared, and judiciously administered, is perhaps the safest general anæsthetic in use; it is very efficient for minor surgical operations, and we believe it will ere long be found applicable to the more protracted and graver operations. Its efficiency is very much modified by its preparation and mode of administration. This gas when pure is colorless, and of slightly sweetish taste and odor; it is usually prepared by decomposition of nitrate of ammonia.

It is not the purpose here to describe the method of preparing this agent—that has been well done by others; yet it is proper to suggest here that, to a large extent, the knowledge and opinions entertained on this subject have been very circumscribed, and exceedingly erroneous. In the administration of nitrous oxide as an anæsthetic, great care should be exercised to secure the best results. In order to accomplish this, it should be inhaled, and in no case but once, diluted, as circumstances may indicate, more or less with pure atmospheric air; this is ordinarily necessary only at the beginning, for pure nitrous oxide will sustain respiration for an indefinite time.

To a patient in an anæsthetic state, it is not so

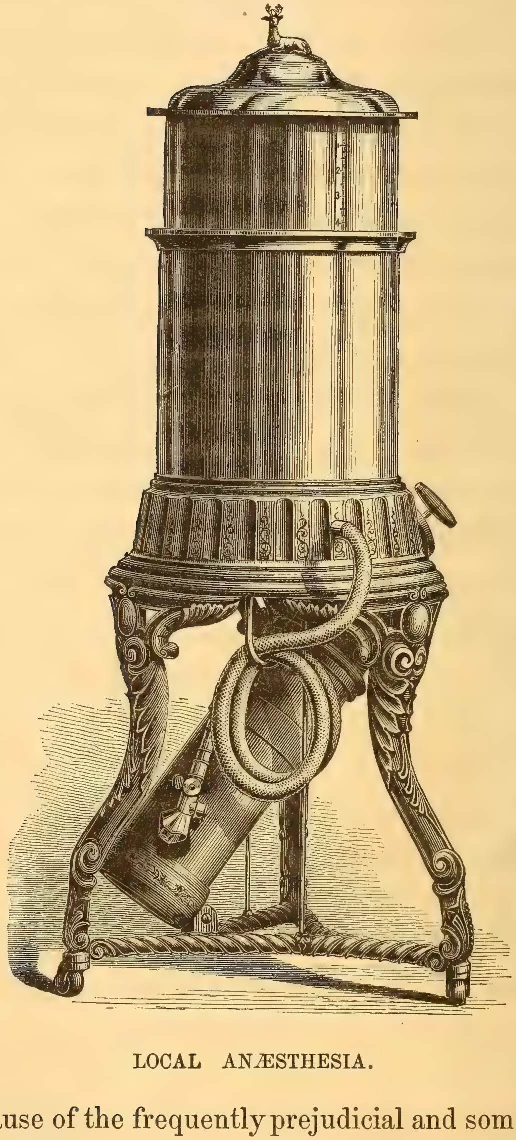
readily administered as chloroform or ether; but the patient under its influence is quite as manageable as with any other agent, and the anæsthesia as perfect, but not as prolonged without continued administration.

It is scarcely justifiable in ordinary dental practice to use a more heroic general anæsthetic than the one here referred to.

Nitrous oxide gas is now prepared in liquid form, and may be procured of the manufacturers, ready for use. There are some advantages derivable from this. The gas in this form is prepared by persons of extended knowledge and experience in chemical work, which gives assurance of purity; and, in addition to this, by the condensation to the liquid form, any extraneous gases are expelled, and thus there is far greater certainty of obtaining pure gas than when it is prepared in the ordinary way, and that by persons having little or no knowledge of chemical science or processes.

The accompanying cut represents an ornamental, convenient and efficient gas holder. The liquid gas is contained in the cylinder in the lower part; from this the gas escapes into the holder above, directly from which the gas is administered to the patient. A portable apparatus for holding and administering the gas is also constructed, which for some purposes is preferable to this.

Fig. 123.



LOCAL ANÆSTHESIA.

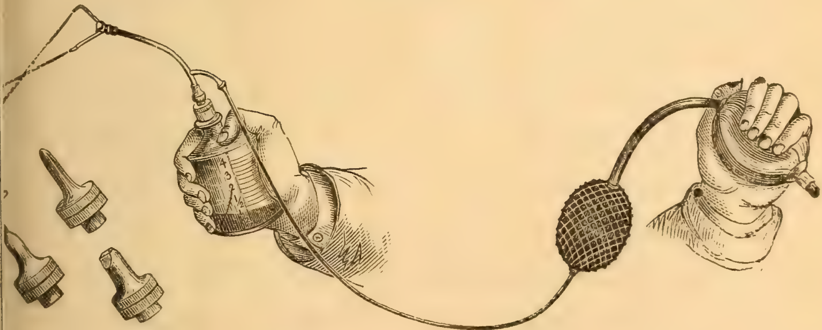
Because of the frequently prejudicial and sometimes fatal consequences to which systemic anæsthesia is

liable, local anæsthesia has been brought into requisition; the first method of accomplishing this was by

Congelation.—Freezing a part, to produce insensibility under surgical operations, is a process that has long been in use. Various methods for accomplishing it have been employed. There are perhaps none so well adapted to the artist's use as ether spray. So easy of application is it, and so generally efficient, that it is in almost universal use. To Dr. Richardson, of London, is due the credit of having brought this process to its present state of perfection.

So accurately does the accompanying engraving (Fig. 124) represent the apparatus used in this pro-

Fig. 124.



cess, that a minute description is unnecessary. The mode of application and operation is apparent at once.

The instrument consists of the fluid holder—a four-ounce bottle, graduated—the bellows consisting

of a rubber ball, with the proper valves, and the points from which proceed the spray, and these all connected by the proper-sized flexible tube.

It will be observed that there are variously-formed points, single and double, straight and curved; these are required for the various processes to which the instrument is applied.

For the extraction of teeth, the double point is applicable, throwing a jet upon the gum each side of the tooth at the same time. The single points are required where an incision or excision is to be made.

This is a very valuable instrument, and is extensively used in minor surgical operations, and is especially adapted to the dentist's use. Ether is perhaps as yet the best agent employed. Rhigolene, a far more volatile fluid than ether, has been used to a limited extent, but owing to its exceedingly rapid evaporation, its action is too violent, and not so easily controlled.

For inducing local anæsthesia, various preparations have been suggested. The following has been in use for several years, namely, a mixture of chloroform, tincture of aconite, belladonna, and opium.

This applied to the gums, or, indeed, to any other surface tissue, will in many cases very much obtund sensibility, and in some relieve it altogether, so that

a tooth may be extracted, or a deep incision made, without pain.

The dental pain obtunder which was introduced to the profession about three years ago, for relieving sensitive dentine, is a good local anæsthetic. Another preparation, made and introduced by Dr. C. Von Bonhorst, is also quite efficient.

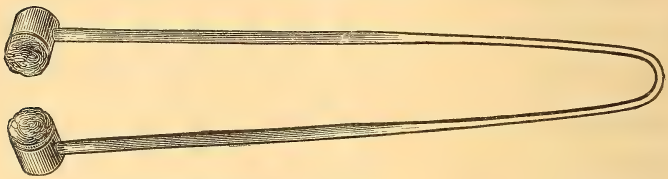
Dr. Von B. has invented an instrument for using his preparation, or any other for like purpose. It consists of two small metallic cups, attached to the ends of an elongated staple, of heavy wire, about seven inches long. This is the handle of the appliance.

The sponges are placed in sections of rubber tube, about half an inch in length, and these together are placed in the cups. The sponges are saturated with the anæsthetic fluid that may be selected, and are applied to the gum on each side of the tooth to be extracted, and retained on the part from one half to two minutes; the length of time will be governed by the susceptibility of the part, the agent employed, and the extent of the anæthesia sought.

Entire insensibility to pain cannot thus always be obtained, but in many cases it can, and diminution of it in all cases can be effected. This appliance is very convenient for the purpose for which it is used.

The following cut (Fig. 125) represents the instrument ready for use.

(Fig. 125.)



EXTRACTION BY ELECTRO-MAGNETISM.

The employment of electro-magnetism in the extraction of teeth was introduced to the profession about fifteen years ago, and at one time was extensively used. There is a great diversity of opinion as to its efficiency for relieving pain; for, while some have been disposed to assume that, when properly employed, it would in the majority of cases mitigate pain, and in many obviate it altogether, others, after having thoroughly tested it, as they affirm, maintain that it does not produce insensibility to any appreciable extent, and consequently does not relieve the pain, but that, at most, it only complicates the sensations, the pain of the tooth-drawing becoming involved in the confusion of other feelings, so that the patient can hardly decide whether he has been definitely hurt or not.

In using this agent for the purpose of extracting teeth, the susceptibility of the patient to its influence

must be carefully regarded. Some persons are so peculiarly constituted that an electric current is almost intolerable to them, while others will receive a strong current with pleasurable sensations. To the former, the electricity would be as painful as the extraction of the tooth; but to the latter, when properly applied, it mitigates, and in many cases altogether obviates, the pain. The reason of this difference in its action is not very clearly understood. Several theories in regard to it have been advanced, but none of them sufficiently plausible to challenge conviction.

Again, the manner in which, and the condition of the parts to which, this agency is applied, are to be closely observed. Where there is acute periostitis, an electric current, even though feeble, would produce intense pain, and should not be applied; though in such cases it has been suggested that an application of the charged sponge to the gums will produce insensibility.

APPLICATION.

The method of application is very simple. Any ordinary battery, of convenient form, may be employed for this purpose. It should be uniform in its action, and the vibration as short as possible. The common zinc-and-copper battery, with the sulphate-of-iron solution, is perhaps the most convenient and

safe. One pole of the battery—no matter which—is attached to the forceps, and the other to a handle of size and form convenient for the patient to grasp. To ascertain his susceptibility, the current should always first be tested on the patient, by placing the handle and the forceps one in each of his hands, and letting it on first feebly, and then gradually increasing it till he experiences the sensation just beyond the elbows; when, finally, it is to be slightly weakened. The gum having been separated, the forceps, with its appendages, is adjusted to the tooth, the connection made by placing the handle in the patient's hand, and the tooth at that moment removed. It has been recommended by some to place the forceps on the tooth, and complete the circuit as above, with the current very feeble, and then gradually increase it to the proper force for the operation. In some instances, perhaps, this would be the preferable mode.

Another method of producing insensibility by an electric current is, to place two moistened sponges, connected with the two poles of the battery, on the gum, one on each side of the tooth, keep them there a few moments, and then operate. This method, however, has not yet been sufficiently tested to ascertain its merits.

APPENDIX.

In the following pages are presented a few subjects, more at length than is practicable or desirable in the body of the work.

Section A. consists of selections from "WATT'S CHEMICAL ESSAYS" on "Caries of the Teeth."

This is perhaps the most accurate and concise presentation of that subject in the English language. In treating of the subject, it deals with established principles and with facts, and discards all mere hypothesis, which has commonly entered so largely into the discussion of the subject. A careful and thorough study of the subject, as here presented, is suggested. T.

SECTION A.—DENTAL CARIES.

It is now admitted, by all who are familiar with the subject, that, whatever may be the predisposing causes, the immediate cause of dental caries is chemical action. It is well known that constitutional causes have much to do with this disease, both in producing badly-organized, defective teeth, and in eliminating or preparing the agents which act chemically on them. But no constitution produces teeth so defective that they undergo spontaneous decomposition while retaining a vital connection with the general system. I am aware that a few pathologists still maintain that inflammation of the bony texture of the teeth is liable to the same terminations as inflammation of ordinary bony tissue; but it is not profitable to debate this point in the present paper. Suffice it to say that the structure and position of the enamel indicate that the danger is from without, not from within.

As soon as it is admitted that decay of the teeth results from chemical action, it is natural to inquire what agent or agents produce this action. Accordingly we find the profession turned at once in this direction. And when the composition of the teeth is taken into the account, we would infer that the deleterious agents are to be looked for among the acids. And here we have had great confusion of ideas, and are still likely to have it. For example, we are told " that it is proven that nearly all the acids, both mineral and vegetable, act readily upon the teeth." (*Harris' Dictionary*, article " Caries of the Teeth.") Upon any part of the teeth? Or are we to understand that some of them act on the animal portion, some on the earthy, and some, or all, on the enamel? Just turn to the index of almost any chemical text-book, and ask yourself if it is proved that nearly all of the acids there named act readily upon the teeth. Do carbonic acid, tannic acid, and scores of others that might be named, act *readily* upon the teeth? This expression, and many others that might be quoted from various writers, show a professional longing for, rather than an attainment of, the truth in regard to this matter.

Now, for convenience, let us assume that dental caries is produced by the action of acids. The question still arises, what acids? Are many acids, or only a few, concerned in its production? One of the laws of combination teaches us that chemical compounds are definite in their nature. Chemical action is always definite. When an acid combines with an alkali, or base, a definite compound, called a salt, is formed. When a different acid unites with this same base, a different salt is formed. Each salt, each chemical compound of any kind, is distinguished from all others by characteristics peculiar to itself. It is unlike all other substances, in some respects. Each chemical result differs from all other chemical results. Of course, then, a great variety of chemical reagents will produce a great variety of chemical reactions.

Let us now inquire as to the various characteristics of those chemical actions which result in what we recognize as dental caries. Do we here find a great variety of appearances? Or is it not well known that the phenomena of caries are so few, and so circumscribed, that by common professional consent, but three or four vari-

eties of it are recognized? We find one variety often called "white decay," and another that is brownish in color, and a third that is very properly designated as "black decay." These differ in other respects as well as in color. In the white variety all the components of the teeth are acted on, and disintegrated, as far as the disease extends. In the second variety, the earthy portion of the teeth seems to be removed, while much or all of the animal portion remains, which is conclusive evidence that the chemical agent, whatever it may be, forms soluble compounds with the earthy materials. In the "black decay" there is less disintegration of the tooth substance than in either of the other varieties; and it progresses less rapidly than either of them. The physical characteristics of this variety, aside from the chemical, would indicate that the chemical agent principally concerned in its production forms, mainly, insoluble compounds with the constituents of the tooth. Then, there is a fourth variety, commonly called "chemical abrasion," in which the entire tooth-substance is *removed*, as far as the disease extends. It is evident that the agent producing this, dissolves or forms soluble compounds with both the animal and earthy materials of the tooth.

Unless we conclude that chemical compounds are not definite in their nature, and that many reagents may produce but a few reactions, we are forced to the conclusion that dental caries, as observed and recognized, results from the action of but few substances on the teeth. It is very probable that each *distinct* variety is produced by the action of a single agent, and invariably by the same agent. I am well aware that more than one variety may be found in the same mouth at the same time, and in close proximity; and, consequently, any given case of caries may partake of the characteristics of more than one variety. It is not uncommon to find "white decay" attacking a tooth in a cavity primarily affected with the brown, or colorless variety. But every practitioner is familiar with unmixed cases, representing all the four classes specified.

The physical characteristics of decay depend much on the texture of the teeth affected; but they are dependent, also, on the nature of the compounds formed by the union of the destroying agent with the constituents of the teeth. The degree of concen-

tration of the chemical agent has also a modifying influence. When much diluted, its action is almost solely in obedience to its strongest affinity. For example, if nitric acid were the agent, when concentrated it would act energetically on the animal as well as on the earthy materials of the teeth ; but when much diluted, its action would be almost confined to the latter.

The chemical characteristics of decay, however, depend almost exclusively on the character of the agent producing it. The truth of this appears evident when we reflect that bad teeth and good ones are composed of the same chemical substances. Marble and chalk are alike in chemical composition, but not in physical structure; and though an acid acts more rapidly on the latter than on the former, yet the result of the action is the same. An acid, too, will act with more energy on a soft, porous tooth, than on one of firmer texture; yet the chemical results are the same. It is safe to conclude, then, that as there are but few *results* in the chemical actions attendant on dental caries, there are but few chemical agents immediately concerned in their production.

It is not to be inferred from the above that but few agents are capable of injuring the teeth by chemical action. Many acids used in food or as medicines are capable of doing injury to the teeth. But no one need suppose that an acid, even though considerably concentrated, brought occasionally in contact with the teeth, is the immediate cause of caries. Every close observer will conclude that caries is the result of an agent acting slowly and steadily in the accomplishment of its work. He will be apt to infer that this agent is either formed by chemical action within the mouth, or is eliminated therein, either as a secretion or an excretion, and that it quietly performs its disastrous deeds as fast as formed or eliminated. The application to the teeth of an acid capable of acting chemically on them, facilitates or predisposes to the production of caries; and this it may do without this acid being the *immediate* cause of the decay. A tooth may be fractured, or its enamel be removed, by mechanical means; and as the dentine is thus exposed, the tooth is more liable to caries than before the exposure. But no one supposes that the mechanical action which exposes the dentine is the immediate cause of the

caries. The dentine would remain sound and healthy did not some chemical agent attack it. In like manner, in the administration of acids as food or medicine, the teeth may be so corroded as to expose the dentine, and render it as liable to the action of the carious agent as in the former case; or if the dentine is not exposed, the enamel may be roughened, either mechanically or chemically, so as to afford a lodgment for organic matter, which, by decomposition, may generate one of the acids immediately concerned in the production of caries. On this principle, acid medicines and acid foods may indirectly, but not immediately, cause caries. The same remarks will apply to acids brought in contact with the teeth by eructation or vomiting.

If this view is correct, the investigation of the subject of dental caries is brought within a narrower compass than many suppose. The first step is to inquire what acids, in health and disease, are liable to be secreted or excreted, so as to be brought regularly in contact with the teeth. The second is to ascertain what acids are liable to be formed within the mouth by fermentation or otherwise. And the third is to discover what ones of all these are capable of producing the phenomena of dental caries. There is but little room to doubt that, at least, each of the first three varieties is the result of a *specific* agent.

To properly understand any chemical action to which the teeth are subject, it is necessary to bear in mind their texture and composition, and to consider the chemical properties of at least their principal constituents. It must also be remembered that the teeth are endowed with vitality. As dental caries—the most common disease of the human race—is now universally conceded to be the result of chemical action, the importance of this subject is at once manifest. The time is not far distant when in every case of recent caries, the enlightened practitioner will be able, by the character of the decay and the habits and constitution of the patient, to detect and identify the agent or agents producing the disease. Any practice short of this knowledge must be, at least to some extent, guesswork, and is, although the best we can now do, empirical practice.

The fact that an active alkaline base is the principal inorganic

ingredient of the teeth, would indicate clearly that their great danger lies in the presence of acids; and all experience demonstrates the truth of this inference. This danger is also greater from the fact that the principal salt of this base, present in the tooth-substance, combines with several acids without undergoing decomposition.

It is evident that the acids do not all act alike on the teeth. Indeed, some exert no influence whatever on them, while others act with great energy on each and all of their constituents. It would be an endless task to consider all the substances which are capable of exerting an injurious chemical influence on the teeth; and perhaps it would be as unprofitable as endless. All that is now aimed at is an accurate account of the various substances which ordinarily act chemically on the teeth—which produce caries and "chemical abrasion."

Without further preface, we will proceed to notice some of the the chemical agents alluded to.

Nitric Acid.—This acid is composed of five equivalents of oxygen united with one of nitrogen. Its symbol is therefore, NO_5. It acts with great energy on all the constituents of the tooth. Its great energy of action depends on a variety of circumstances. As an acid, it unites energetically with bases, and will, therefore, take the lime and kindred bases from the weaker acids. From its ready decomposition, it affords oxygen, in its nascent condition, for the destruction of oxydizable substances. Its action on the tooth may be thus briefly described: it dissolves the phosphate of lime, decomposes the carbonate, setting the carbonic acid free, and forming nitrate of lime, and destroys the organic portion, producing a highly-softened state of the carious matter. In fact, it is a prominent, if not the principal, agent in the production of the "white decay."

But the question naturally arises, Is an agent so destructive in its tendencies likely to come in contact with the teeth, and if so, under what circumstances? The question is important, and the answer, perhaps, difficult.

It is well known that this acid is frequently administered as a tonic; and it is a lamentable fact that far too little attention is paid

to the prevention of its injurious effects on the teeth in such cases. but this will by no means account for the frequency with which it evidently injures the dental organs. A few thoughts in regard to its formation may throw some light on the subject.

It is a singular fact that though nitrogen and oxygen manifest but little affinity for each other, yet they unite in various proportions, forming at least five well-known distinct compounds. It appears, however, from a variety of circumstances, that their tendency is to unite in the proportions which form nitric acid. The protoxyd is readily decomposed, and yields nitrogen, oxygen, and *nitrous acid.* The binoxyd, if brought in contact with the atmosphere, takes from it two equivalents of oxygen, and also becomes *nitrous acid*, or NO_4. Hyponitrous acid, NO_3, on admixture with water, is converted into nitric acid and binoxyd of nitrogen, thus: $3NO_3 = NO_5 + 2NO_2$, in which case the latter will be converted into nitrous acid, which, in the presence of water, is converted into *nitric acid* and binoxyd of nitrogen.

It follows from this that, if oxygen and nitrogen unite at all in the mouth, let the proportions be, at the first, what they will, nitric acid must be the ultimate result—as air and moisture, the only agents necessary in the transformation, are here always present.

The reader will now think of the mucus, and particles of nitrogenous food lodged about the teeth undergoing decomposition, and yielding nitrogen to the oxygen of the atmosphere, or of the fluids of the mouth, and will conclude that all is explained. Well, perhaps it is. But let us consider. Nitrogen is emphatically a "conservative" element, and manifests but little tendency to unite with anything, and especially with oxygen. It is probable, therefore, that these two elements unite indirectly. It should be borne in mind that organic nitrogenous bodies contain hydrogen and oxygen, as well as nitrogen. Consequently, by their decomposition, these elements are all liberated. The mutual affinities of hydrogen and nitrogen take precedence, and the result is the formation of ammonia, NH_3. But ammonia exposed to the action of oxygen is always decomposed; an oxyd of nitrogen is formed, and of course *nitric acid* is the result.

With this view of the case, and from the fact that many persons

permit the buccal mucus as well as particles of nitrogenous food to remain around, upon, and between the teeth, till decomposition is effected, it is not surprising that the white variety of dental caries is so frequently found.

Nitric acid is also sometimes formed in the mouth by the agency of galvanic action. When two metals are placed in the mouth in proximity to each other, and the fluids of the mouth are capable of acting on one of them, galvanic action is established. And if they are so situated that the mucus membrane forms a connecting conductor, by being in contact with both, especially if the metallic surfaces be considerable, a current is established sufficient to decompose any of the binary compounds contained in these fluids. The liberated nitrogen, hydrogen, and oxygen will result, as above, in the formation of ammonia, and then nitric acid. But galvanic action in the mouth is more likely to develop hydrochloric than nitric acid. This will be noticed again.

Sulphuric Acid.—Sulphuric acid is composed of 16 parts of sulphur united with 24 of oxygen. Its symbol is, therefore SO_3. In addition to those properties which characterize it as an acid, it is a powerful caustic poison, and promptly destroys the various tissues with which it comes in contact. Its chemical action on ordinary tissues depends principally on its affinity for water, but not altogether; for it has the ability to coagulate and unite with albumen, and to dissolve fibrin. In common with other acids, it has a strong affinity for alkaline bases.

With these properties in view, let us examine its action on the teeth.

The affinity of this acid for water is so energetic that it seems even to force its elements to forsake favorite combinations, and to unite with each other, that it may be gratified. For example, a cork in a bottle of sulphuric acid becomes dark-colored, and is really charred. Now a cork, like other wood, is mainly composed of carbon, hydrogen, and oxygen—the latter two being in the proper proportions to form water. Their affinity for each other, quickened by that of the acid for the result of their combination, causes them to forsake the carbon, unite with each other to form water, and then combine with the acid. The same phenomena

occur when it acts on animal tissues; for they are principally composed of the above-named elements, with the addition of nitrogen. Accordingly, "black spots are frequently observed in the stomachs of those who have swallowed the acid." Now, that its slow and prolonged action on the gelatinous portion of the tooth would result in its carbonization, is a conclusion justified both by inference and experiment. But carbonized gelatin is "animal charcoal," the color of which is a prominent characteristic of "black decay."

The phosphate of lime in the tooth, which is not the neutral, but a subphosphate, is not soluble in sulphuric acid; nor is the acid capable of decomposing it, except in the presence of alcohol. It follows, then, that this acid does not break down the texture of the tooth to the extent that some others do, simply because it cannot unite with, or, under ordinary circumstances, decompose the principal earthy salt of which it is composed. And here we have a second characteristic of "black decay."

It is now time to inquire whether at all, and if so, by what means, and under what circumstances, this acid is brought in contact with the dental organs.

Sulphuric, like nitric acid, is frequently administered as a medicine, and generally with criminal negligence in respect to its action on the teeth. But we cannot regard this as the only or principal source of danger from this acid. If oxygen unites at all with sulphur, the tendency, under ordinary circumstances, is to the formation of sulphuric acid, as sulphurous acid in the presence of moisture is rapidly converted into the sulphuric. The whole question, then, is reduced to this, Is sulphur ordinarily present in the mouth, and liable there to become oxydized?

Albumen is a constituent of mucus, and is contained in many articles of food. Sulphur, if not a constituent of, is always united with albumen. Its ordinary presence in the mouth is therefore easily explained. Sulphur and oxygen unite directly, under various circumstances, as in the combustion of sulphur; but it is probable that the union here is effected by indirect means. Hydrosulphic acid, or sulphuretted hydrogen, is one of the results of the putrefactive decomposition of albuminous substances. The breaths of our patients often bear ample testimony to its presence

in the mouth. Now, the oxygen of the atmosphere rapidly decomposes this acid by taking its hydrogen to form water. The sulphur is therefore set free, and being in its nascent state, its affinities are increased in energy, and it also unites with oxygen, forming sulphurous acid, SO_2, which in the presence of the water of the saliva is rapidly converted into sulphuric acid, or SO_3.

The quantity of sulphur present in the mouth at any one time is very minute; and a great proportion of this is exhaled by the breath before it has time to undergo decomposition. And sulphuric acid, as already noticed, has a weaker affinity for the constituents of the tooth than some others. Hence "black decay" is not so frequently met with as some other varieties. And as from the nature of the chemical action the texture of the tooth is not so entirely broken up, the carbonized portion protects the parts beneath it. This variety of decay therefore progresses less rapidly than others.

Hydrochloric Acid.—This acid is also called chloro-hydric and muriatic acid. It is composed of 35 parts of chlorine, united with 1 of hydrogen. Its symbol is HCl. Though its elements manifest a strong affinity for each other, yet it is very readily decomposed; and many of its chemical manifestations result from the action of one or both of its liberated elements. It is on this principle the acid attacks metals—being decomposed, the chlorine unites with the metal to form a chloride, and the hydrogen escapes with effervescence.

This acid, like those previously considered, is a caustic poison. Its escharotic power depends mainly on its affinity for water, which is very active, and on its ability to coagulate albumen. Its chemical action is generally inferior to that of the two acids just considered. It unites with bases, forming a class of salts called hydrochlorates; and sometimes it combines with a salt without decomposing it, or being itself decomposed. When concentrated, it dissolves animal tissues, but is in this respect far inferior to nitric acid. When much diluted and mixed with dried mucous membrane, it dissolves coagulated albumen, fibrin, etc., performing to all appearance an artificial digestion.

A careful observation of these properties will enable us to understand the action of this acid on the tooth.

The carbonate of lime and the acid are mutually decomposed. The results are chloride of calcium, water, and carbonic acid. The decomposition may be represented by the following equation:

$$CaO,CO_2 + HCl = CaCl + HO + CO_2.$$

The carbonic acid of course escapes as a gas, and the chloride, being very soluble, is dissolved in the saliva, and thus removed from the tooth.

The phosphate of lime (bone phosphate), though not decomposed by, is highly soluble in hydrochloric acid. It is dissolved, and is thus removed from the organic portion of the tooth.

We have seen that this acid, unless highly concentrated, is not capable of dissolving the animal portion of the tooth. As this concentration is not likely to take place in the mouth, it follows that, when hydrochloric acid is the cause of dental caries, the earthy portion is dissolved and removed, while the animal portion principally remains in the carious cavity. And here we have the prominent characteristics of a third variety of decay.

I have not taken into the account any of the earthy salts contained in the tooth, but the phosphate and carbonate of lime. They are present in such small quantities that they exert but little influence on any of the chemical actions which we have considered.

Hydrochloric acid is also administered as a medicine; and the remarks made on the preceding acids apply equally here. This acid is an ingredient of the gastric fluid, and is often present in abnormal quantities in the stomach, from which it is thrown into the mouth by eructation and vomiting. But we cannot thus account satisfactorily for the frequency with which the dental organs are evidently injured by this acid.

Though in its normal state the saliva is alkaline, yet in a variety of abnormal conditions it contains one or more free acids; and the hydrochloric is one of those most frequently present. It often originates no doubt in the decomposition of the soluble chlorides contained in the saliva and mucus. When the chlorine of these is liberated, it takes hydrogen from the water of the saliva, and this acid is a result of the union.

But sometimes hydrochloric acid is directly furnished by the salivary glands, either as a secretion or an excretion. The system

may contain just its normal quantity of chlorine, but if there be a deficiency of sodium or potassium, the relative excess of chlorine is converted into hydrochloric acid. In this case the acid is secreted. Or the quantity of potassium, and sodium may be normal, with an excess of chlorine. The excess will unite as before with hydrogen, and the acid will be excreted. At all events, this acid is usually found in the mouth when the mucous membrane is inflamed, as well as in patients who indulge in the excessive use of salted meats.

Galvanic currents in the mouth always result in the formation of this acid. The chlorides of sodium and potassium, present in normal mucus and saliva, are decomposed, and their chlorine unites with hydrogen derived from the water of the saliva. It is on this principle that we frequently find a decayed surface around a gold filling, which is in close proximity with one of a different metal, or with a silver plate or clasp. In such decays, the animal portion usually remains, while the earthy portion is removed, just as would be expected from the prolonged action of dilute hydrochloric acid.

In these observations we have endeavored to set forth the results of the ordinary uninterrupted action of these acids on the teeth; and we have seen that they are capable of producing the three varieties of decay usually described, though we by no means maintain that they are the only agents capable of causing these results. Their actions, and consequently the characteristics of decay produced by them, are doubtless much modified by circumstances. One of them may be the destructive agent in the commencement of the caries, and, in process of time, another may be developed, and exert its specific influence on the same cavity. Then the phenomena would of course be complex. Again, it should be remembered that a strong affinity for water is a property common to all of them. It is possible therefore that carbonization or blackening, may result from the action of any of them, yet it is by no means probable, at least with nitric acid.

SECTION B.—DR. CORYDON PALMER'S PLUGGING INSTRUMENTS.

In the following pages are given a description, and the mode of using Dr Palmer's very complete set of plugging instruments.

They are illustrated in this volume, page 136 (Fig. 55). The manner of using them is so explicitly given in these pages, that no one of experience in the use of instruments can fail to apply them as intended.

They constitute, altogether, the most perfect set of plugging instruments ever devised. They more nearly meet every case, that may be presented, than anything heretofore used.

Several instruments, accessory to the set, are here described, that are not illustrated in this volume; they are all, however, very valuable, and exactly adapted to the purpose for which they were designed. T.

In the designing of these instruments for the profession, it has been my aim to perfect a set that shall enable the operator to reach with mallet force any case that may be presented.

A course of practical experiments dating back to the introduction of the use of the mallet, has brought me to the present designs.

In conducting the course, my object has been—First, to get the best adaptations; second, to have as few curves as possible; and third, the least number of instruments that will do all the work; and lastly, to have the size and length of each instrument proportionate to its use.

There is no one thing that we owe so much to our fellow-practitioners as to give to each credit for what he does toward the improvement and elevation of our science.

For my own part, I do not claim entire originality in the forms of my instruments. For principles, I am indebted to our worthy friend, William H. Atkinson, and for valuable interchanges to Charles R. Butler.

All instruments for mallet forces can be but modifications of the foot. My efforts have been to produce a mallet set, to be used in

their numerical order, that shall indicate a systematic course of operating.

The plugging set consists of thirty-five pieces. Up to No. 16, they pertain to the incisors; and I would especially recommend that they be used only upon these teeth. The tendency will be to use them in every case; but it is too much risk for such fine points.

Do not pick up the gold upon the point of the instrument and hold it in the lamp, as it will quickly destroy the temper.

From No. 17 *to* 30, the instruments pertain to the bicuspids and molars.

In order to describe the instruments, we must suppose a case:

Left superior central, anterior approximal surface, cavity, prepared with fine retaining pits at each angle of the cervical wall.

The first three in the order of their arrangement are cutting instruments, and designated by dots to distinguish them from the pluggers. The first one is a fine elastic drill, for retaining pits. The second is a fine scoop for clearing the pit. The third is a curved side-cut, for clearing the last particles from the cavity proper. These three instruments are indispensable to the last preparation of the cavity, and must necessarily be classified with the pluggers for the present; but it is my intention that they shall comprise the last and higher numbers of a systematic-set of cutting instruments to be brought forward in due course of time.

The two instruments No. 0, are holders for keeping the gold in position until it can be tacked fast. The one with a guard in the centre is to be used when no assistant is at hand; and when held between the first and second fingers, the guard is designed to prevent the fingers from slipping down. The rounded top will be useful upon which at times to rest the forefinger of the left hand at the first joint, and help to regain position of the fingers.

Holders are important instruments, not familiar to all. I would draw attention to their use. I feel a particular pride in this one new design. It is purposely short, in order to bring it more easily under control; and having the guard, will enable the operator to hold it and the plugger in one hand, at the same time.

The manner of retaining is to place the holder between the first

and second fingers of the left hand, letting them rest upon the guard, and place the plugger between the thumb and forefinger, letting the points of the instrument cross in the cavity.

No. 0, *without a guard*, is to be used when the help of an assistant is at hand, and taken up at choice.

The two holders and the plugger may form at times a useful trio. Used without an assistant, the three can be held in position by the left hand, and the stroke given by the right; or, with assistant help, the two holders in the left and the plugger in the right hand.

The manner of holding the three in one hand is to place the two holders in position, as above described, and then add the plugger between the thumb and forefinger, in front of the holders, letting the points come in position. With assistant help, the two holders are held in position as above, and the plugger held in the right hand.

I do not wish to be understood that the holder is to be used throughout an entire operation; but that in the starting of a filling, it is indispensable, and at other times useful, as may be indicated.

No. 1, *Pit Point*, is to introduce the first pieces of gold into the retaining pits, and fill all minute cavities upon the labial surfaces, where ease of access and direct force can be had.

No 2, *Small Foot*, is to introduce the first pieces of gold after the pits are filled, and is to be applied until the gold is made to extend from one pit to the other and firmly attached.

No. 3, *Foot*, is to add a portion after No. 2, and do the burthen of the work in filling the cavity even with the edges of the wall.

No. 4, *Foot*, is to be used to lay the gold along the cervical wall, by letting the heel pass into the cavity, and the point project obliquely beyond the edge of the wall, so as to carry the gold hard upon and perfectly along its whole line.

No. 5, *Curved Foot*, is to apply upon the inner surface of the labial wall, by opening the mouth and applying it direct from the lingual surface. Its curved point will admit of its being brought in contact with the wall with less danger of fracture than the plane foot. It also has a working point, which may be applied with directing force with advantage.

No. 6, *Double Serrated Pit Point*, is to carry the gold into the apex of the cavity, toward the cutting edge of the tooth. This instrument deserves especial notice. It enables the operator to carry the gold with mallet force into this part of the cavity with ease and certainty. It must be used with *careful directing force*, and can be applied either from the labial or lingual surface.

No. 7, *Slot Plugger*, applies in filling the slot, extending from the apex of the cavity to and along the line of the cutting edge, or wherever slots occur upon the incisors.

No. 8, *Lingual Modeler*, applies in modeling up the lingual ridges of the incisors. Its form enables the operator to hold the point to or from him, without danger of impigning upon the adjoining tooth. By opening the mouth, direct force can be given. It will be observed that this and several of the other instruments are sloped forward in the handle, in order to favor their introduction from the lingual surface.

No. 9, *Lingual Mallet Burnisher*, applies in the last condensing of the gold, along the lingual edges of the cavity. Held at an angle bringing it to bear upon one of its sloping faces, it can be made to glide along, or bringing the point more to bear will follow minute lines, as may be desired.

No. 10, *Curved Cervical Modeler*, applies in modeling the gold at the cervical wall of both the incisors and bicuspids; is indispensable for condensing the anterior and posterior surfaces of bicuspid fillings. It will be found to reach these surfaces most admirably. By applying it as the operation progresses, the approximal surfaces may be modeled into form.

No. 11, *Curved Approximal Modeler*, applies upon the approximal surface of the gold, after the cavity is filled even with the edges of the walls, and does all the remainder of the modeling of this part of the filling. The gold is to be laid on in flat pieces, and the instrument applied, both from the labial and lingual surfaces. Its curve enables the operator to pass it through so far between the teeth as to easily reach all parts of the approximal surface. This instrument forms a marked feature in the set, and becomes a great favorite.

No. 12, *Curved Crown Modeler.* This instrument applies upon

the cutting edges of the incisors and the elongation of their crowns, and upon all the teeth where direct force is required upon a flat surface.

No 13, *Curved Cusp Modeler.* In the operation of elongating the crowns of the incisors, the labial and lingual surfaces of the gold must be condensed, as the operation progresses. Direct force is not admissible, and this instrument, held at an angle, meets the case. It is also designed to model cusps and fissures.

No. 14, *Curved Model Separator*, applies with mallet force in effecting a separation between approximal fillings in the incisors, and can be introduced from the labial or lingual surfaces, as the case may require.

No. 15, *Side Curved Hand Separator.* Useful in effecting a separation of the fillings, same as No. 14.

No. 16, *Curved Hand Burnisher*, for the last condensing and finish of the filling in the incisors.

Nos. 17 *and* 18, *Foot Instruments*, are the same size upon their working faces as Nos. 2, and 3, and are to take their place upon the bicuspids and molars. Being designed to do the burthen of the work, they are made stouter, and with less angle of face, and less inner curve.

No. 19, *Foot*, is designed to lay the gold upon the cervical walls of the bicuspids and molars, by passing the heel into the cavity, and letting the point project beyond the edge of the cervical wall. Same as the use of No. 4.

No. 20, *Curved Foot*, applies upon the thin curved buccal and lingual walls of the bicuspids and molars.

No. 21, *Slot Pluggers*, used wherever slots occur upon the bicuspids and molars.

No. 22, *Double-curved Holder*, for the bicuspids and molars, and wherever a curved holder is required.

No. 23, *Double-curved Root Plugger*, used with directing force in the palatal roots of the superior molars, and in all cases where large deep root cavities occur. It is the first of a class of eight instruments, purposely designed of a larger size than the previous numbers, in order to enable the operator at times to grasp the instrument firmly in the whole hand, and give directing force.

No. 24, *Double-curved Croze-pointed Plugger*, applies in the deep angles of the posterior cavities of the inferior bicuspids and molars. Used with firm directing force.

No. 25, *Curved Molar Foot*, has a working point, and is designed to introduce all the gold into the inferior central crown cavities of the molars. It applies with the use of the holder, by first securing the gold in the most deep, distal part of the cavity, and then working forward, extending the gold along the sides of the cavity, until the centre is passed, and then turning the point of the instrument and working backward until the walls of the cavity are entirely lined up; then commence and bring up the centre of the filling to finish. This instrument is one of the most universally-acting and rapid-working points with which I am acquainted. It admits of being turned to and from the operator, and works across the mouth with great advantage. The position for the operator for the right inferior molar is back of and above the patient. For the left, if the operator is skilled in the use of the left hand, he need not change positions; but if change is required, stand at the left side and hold the instrument with firm directing force.

Nos. 26 *and* 27, *Right and Left Treble-curved Bicuspid Pluggers*, are designed to introduce the gold into the posterior cavities of the inferior bicuspids and molars. The opinion has largely prevailed that direct mallet force could not be brought to bear upon this class of cavities; but these instruments held in position, will give direct forward force, and can be worked across the mouth with great satisfaction. They also apply upon the superior bicuspids and molars equally well.

Nos. 28 *and* 29, *Right and Left Treble-curved Molar Modelers*, apply at the posterior cervical walls of the inferior bicuspids and molars, and serve to model up all the posterior surface of the fillings, enabling the operator to give most direct forward force. They reach a point that no other instruments will. Posterior lingual cusps can be reached with these instruments, and condensed upon their posterior and lingual angles,—a point that has been hard to reach. They also work across the mouth with great advantage, and can be applied to the superior bicuspids and molars as well. For applying the instrument to the right inferior molar,

stand at the back of and above the patient, holding the instrument firmly in the whole hand, letting the thumb rest upon the shaft of the instrument, and next the cheek, and give tense directing force. For the left, stand upon the left side, grasping the instrument firmly with the whole hand, letting the fingers go next the cheek, and the thumb firm against the shaft, and give tense directing force.

No. 30, Modeling Mallet Burnisher, has a combination of working faces. Held at an angle upon one of its sloping faces, it can be made to glide along, and lay additional pieces of gold, if desired; or, turned more upon its point, will follow fine lines in the modeling of cusps and fissures. It will reach the posterior surfaces of the bicuspids and molars, and can be used for the last hand burnishing of fillings, if desired. Used with the mallet, must be grasped firmly in the whole hand, and given directing force.

A word or two in reference to the finish. The instruments are purposely finished bright and polished throughout; because in a long course of careful practical experiments, I have found that finished in this way they keep better, and are more pleasing to the eye. After the brilliancy of the first finish is worn off, they will assume a certain dull, silvery surface, which makes them pleasant to hold, and they are always clean and presentable.

The Cases are made from a new design of my own, suited to practice.

They contain the plugging instruments, four pieces of forceps, a foil carrier, and dressing needle; all of which are new, and especially designed and adapted to the mouth by myself.

Nos. 1 and No. 2 are punches for the rubber dam, and are so formed that they can be applied to put in new holes after the dam is adjusted, and thus enable the operator to extend the dam without the necessity of removing it from the mouth—a most desirable feature in its use.

The Wedge Cutter is so formed and curved that it can be made to reach any point desired, enabling the operator to cut off a wedge far back in the mouth, or nip a point along the lingual surfaces of the teeth.

The Wedge Forceps is an entirely new instrument, in size and form, pleasant to the hand and eye. Its curve enables the operator

to pass it far back in the mouth, to reach any point desired, and insert or withdraw a wedge, pull off a clipt ligature, or hold a piece of wood for porte polish, to apply upon the lingual surfaces, particularly the inferior incisors. Must not be used for handling engine bits.

The Foil Carrier is to be used for picking up the gold, holding it in the flame of the spirit lamp, and carrying it to the mouth. May be used also for introducing and removing dressings. Must be held between the thumb and forefinger, letting the top of the instrument pass over the back of the hand, and not placing the hand on the top of the instrument. The points are the most advantageously curved for its application to all parts of the mouth. This foil carrier is designed to be useful in a certain mode of practice which I wish to recommend, and that is: during the operation of filling, not to lay down the foil carrier, but place it between the lips. In this way it is always ready, and no time is lost in hunting for it. I must not forget to caution against the danger of letting it fall in the face of the patient, and hope that all are thoughtful enough to be upon their guard in that respect. I dwell a little upon this instrument because it is one of the most important and first looked-for when we are ready to fill. It is not intended to be used as a plugger, and is made purposely light, and not with too stiff a spring, so that it can be held as above described, without an unpleasant strain upon the lips, and yet tempered and stiff enough through the body and points not to bend when used to insert or remove a dressing.

Dressing Needle.—Although this instrument has its more extended range of usefulness, it is so inseparable from the operation of filling, that I consider the case would be incomplete without it.

In the last preparation of a cavity, particularly where there are sensitive surfaces, it is desirable to give a dressing before introducing a filling. This instrument is the one best suited to the purpose.

In case of dressing over exposed nerves, to allay pain, the rounded top will be useful to fix the cotton smoothly in position.

In conclusion, let me say, that the instruments are designed to be graceful in form, artistic in finish, proportionate in size and length —each one having its particular use—together forming one systematic whole.

SECTION C.—MALLETS.

THE ELECTRO-MAGNETIC MALLET.—Electro-magnetism has, within the last three or four years, been applied and used as a motive power for the automatic plugger.

The plugging instrument operated by this force, though not in general use (and perhaps never will be), yet by some it is prized very highly, and used with great efficiency.

To those unacquainted with electric force, and the appliances through which to make it available, this instrument will appear complicated and difficult to keep in proper condition, but to those familiar with it, it is easily controlled and managed.

The following extracts from a paper on the electro-magnetic mallet, by Dr. Louis Jack, is so directly to the point that we can hardly do better than present them here.

He says, "The first attempt to take advantage of electro-magnetism for this purpose, it would appear, must be credited to Mr. G. F. Green, who first produced, according to his own statements, an instrument in which he made use of the power which a heliacal coil has to draw within it towards its middle a piece of iron, suspended, or temporarily held at its either end.

"At each influx of the electrical current the suspended iron would fly to the centre with quickness, to be stopped by the plugger end, arranged to meet it at that point; at this moment the current was shut off, when the mallet would fly back, under the force of a spring, only to return again by the recurrent opening of the circuit.

"The experiments with this class of electric pluggers have proven unsucessful."

Mr. Green made other experiments which were equally unsuccessful.

Dr. Jack further remarks:—"Entirely independent of any knowledge of what Mr. Greene had been doing in this direction, Dr. Bonwill, after watching the working of the armature in the magnetic telegraph, conceived, with true inventive talent, the idea of utilizing this arrangement, and with the necessary modifications

and adaptations to employ the force which impacts the style upon the paper, at the delivery of the same quick blows upon the plugging point. He therefore attached his armature by its middle upon a point at a distance relatively far from the electro-magnet, making the armature act as a mallet. Thus was secured a light and intense blow, and as the armature moved through a small distance, gained the additional quality of rapidity; a combination of qualities of the highest importance rendered his instrument practically efficient.

"Dr. Bonwill has from time to time improved his first instrument, until we now have from his hands one which has proven satisfactory in most respects. To him, therefore, we are indebted for the first useful electro-magnetic mallet."

After Dr. Bonwill had arrived at a point in the construction of this instrument beyond which he concluded not to go, Dr. Jack made some modifications of the instrument, the purport of which may be inferred from the following extracts:

"The objects of this invention are to render the movements simpler and more direct than has heretofore been done, with the ends in view to produce a sharp and decided impact; to lessen the sounds of the movement at both the time of the impact and recoil, and to produce a lighter, cheaper, more convenient and agreeable instrument.

"The principal feature of this invention consists in the form given to the electro-magnet. The core is made the segment of a cylinder, so that when the helices are formed and placed together, they produce a more or less cylindrical body, leaving between them, at the central part, a circular aperture for the reception of a small cylinder.

"This cylinder receives a plugger, which imparts the force of the armature upon the plugger, and at the same time permits freedom of movement and gives direction to the armature.

"There are other improvements depending upon this one, and connected therewith, viz.:

"The form of the armature and its connected parts.

"The form and arrangement of the *circuit closer*.

"The form and arrangement of the interrupter.

"The device employed to deaden the recoil.

"The means of securing the adjustments of the instruments. . . .

"The best results, and the least discomfort of the patient are secured by careful attention to the adjustments.

"It should be noticed in this connection that the greatest economy will be found in having the batteries in clean condition, replenished to good strength, and the zinc plates kept freely amalgamated."

In a paper on the electro-magnetic mallet, by Dr. E. T. Darby, July, 1875, in speaking of the advantages which the electric mallet possesses over all other instruments intended for the purpose of consolidating gold in the operation of filling teeth, he says: "It is purely automatic in its action.

"Its power or force is entirely distinct from anything physical or individual, except the will of the operator, and the touch of his educated finger.

"No more physical force is required to manage it than would guide a pen or hold a pencil.

"The dentist may stand, or sit in his chair, hour after hour, and fell no greater fatigue than would naturally result from restrained position, or concentrated thought.

"Nor is it a labor-saving instrument only; it is a time-saving invention also.

"The length of time required to thoroughly pack the gold in most cavities is lessened at least one-half by the aid of the electric mallet.

"Nor is it a time-saving instrument only, it is a pain-saving appliance as well.

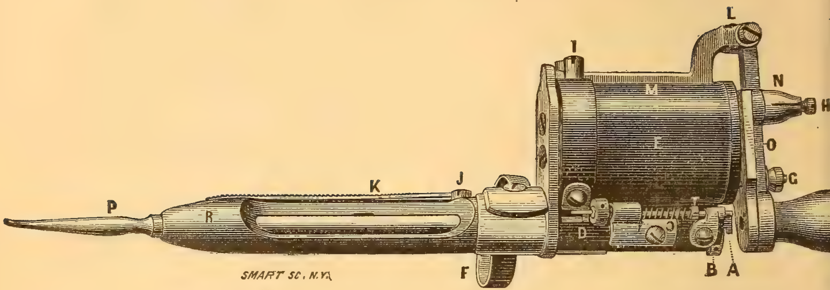
"The blow produced by the electric mallet is sharp and quick, and does not jar the tooth like the hand mallet, or some other automatics.

"The operator must be skilled in its use, otherwise he will fail to accomplish the best results."

The paragraphs above quoted from the two papers referred to on the electric mallet, indicate about an average estimate entertained by those who have become thoroughly familiar with its use.

The following illustration shows the present improved form of the instrument.

Fig. 126.



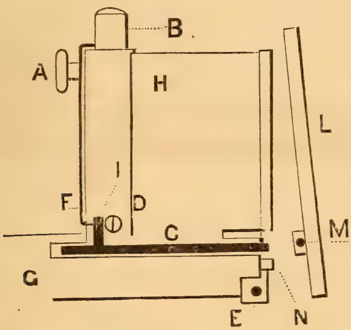
Description of Electro-magnetic Mallet of Dr. Bonwill.—No. 1, ¾ size. E, the horse shoe magnet. M, the brass frame fixed firmly to magnet at the top, and holding the arm O, at L, on two pivoted screws. R, hard rubber handle, with tool P running through it and extending as far to the right under the hammer as A. K, slide key, upon which right index finger rests for making the circuit, and causing the blows in rapid succession by simply pushing slide or key forward. F, the ring through which right index finger passes and supports the mallet and prevents falling. Thumb rests on tool just below K, and revolves tool in any direction. J, an eccentric screw head to regulate the slide K, to make it of very delicate touch. L, posts into which the flexible wires from battery go. N, spiral spring inside for throwing the armature O back against the check screw head C, which head also opens or closes to control the distance the hammer travels. H, screw to regulate strength of spiral spring in N. D, B and A, the automatic brake, which controls the number of blows of hammer. B, screw head for raising or lowering to permit the tool to always keep the right distance to be struck by armature, or hammer. Makes 500 to 3000 blows a minute. Weight, eight ounces, avoirdupois.

Mallet No. 2.—This is exact size of magnets and the frame. It weighs but 6¼ ounces avoirdupois.

H, horse shoe magnets, very compact. L, the armature without frame or hammer thereon. A, screw to regulate the spring of the circuit braker. B, posts for attaching flexible wire from battery. C, automatic brake, which is struck by point of spring F, and is

always pressing hard thereon. E, screw regulator of tool, permitting it to let head of tool project enough to move forward about

Fig. 127.



one-fiftieth of an inch when struck by M on the end of brake C. G, handle of hard rubber.

This is now as complete as can well be made. The first instrument weighed one pound. This last is all we could ask in size and weight, as well as shape. The handle and the hammer on the armature are not shown in the cut of this mallet, nor is the ring.

They are both run by three cups of smallest size Bunsen Coke Battery; it costs about 15 cents a week to charge them. These are the only practical electro-magnetic mallets now in use. As to saving of time, it has been claimed by the inventor that he has packed one-quarter ounce foil in one hour fifteen minutes. It will save three out of four hours, and nearly all the labor.

Automatic Plugger for Engine.—This instrument is the invention of Dr. T. L. Buckingham, and, as the caption indicates, is operated by the dental engine. Those who have used the instrument and are most familiar with it claim that it possesses every available quality for such an appliance. The blow is given by a spring, and is entirely under the control of the operator; it is regulated by a set screw on the head and a movable collar on the hand-piece. The latter can be moved at will during the operation of the instrument, regulating the stroke from the strongest required

to the lightest appreciable touch; or the blows can be suspended altogether and the instrument used as a hand plugger, and that, too, without stopping the engine.

The requirements of delicate operations needing special and precise manipulation, are well met by the skillful use of this instrument.

The bit holder is movable, and is drawn back after each blow by a small spiral spring attachment.

The instrument as ordinarily used gives about eighteen hundred blows per minute, but the number can be greatly reduced by a simple change in the machinery, which can be effected in a few moments, and thus the blows reduced to less than one hundred per minute.

The points used in this are such as are in common use with automatic mallets.

A ring accompanies this instrument, which being attached to it will aid the operator in holding and directing it while operating. It is represented by the following cut (Fig. 128).

Hyde's Pneumatic Plugger.—This instrument was devised and introduced to the profession about 1870. It consists of a small cast iron frame, to which is attached a small cylinder, which with its piston serves as an air pump; this is operated by fly and drive wheels which are arranged in the frame and operated by the foot.

To the cylinder is attached a rubber tube about seven feet in length; to this is attached the hand piece, within which a plunger plays; when in motion this communicates its impulse to the plugger.

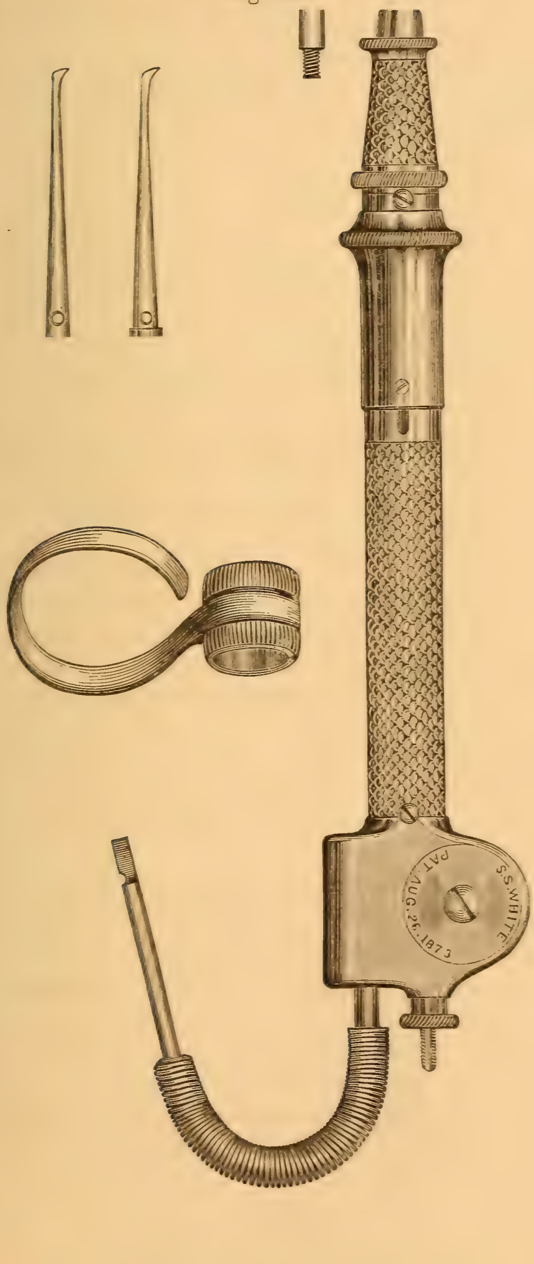
As the plugger in the cylinder is driven to and fro, the hammer in the hand piece responds, expending its force upon the socket piece that holds the plugging point.

The blow is direct and elastic, as the piston or hammer is withdrawn the moment the blow is given.

The rapidity of stroke, as well as the force, is completely under the control of the operator.

This instrument, in the hands of those who have become familiar with it, is very efficient and easily operated.

Fig. 128.



A modification of this instrument has been made, which consists of substituting a rubber ball, about three inches in diameter, for the frame, wheels and cylinder; and the operation is effected by working the foot upon the ball. This certainly has the advantage of being much more simple.

SECTION D.—MATRICES FOR PROXIMAL FILLINGS.

To Dr. Louis Jack belongs the honor of devising and putting into practical form the matrices as aids in filling teeth.

His description of these appliances, and the manner of using them, is so concise and complete, that we have, with his consent, transferred it almost wholly to these pages. By a careful study of the directions here given, almost any one of good manipulative ability will be able to use them with good results. T.

" The first step, in case the teeth are in close contact, is to separate them, either by pressure, or, as in so extensive caries as is under consideration, by a parallel-sided file; and from this slight separation rapidly and freely open by cutting down the enamel at the middle of the space, afterwards increasing somewhat freely with the chisel the inner portion of the opening. Another plan I sometimes pursue, where no fracture of the masticating plate has occurred, is to pass a small five-sided drill until it fails to meet with resistance, increasing by a larger drill; and from these two half circles I cut in either direction with suitable chisels by carefully splitting down the enamel,—first the masticating portion,—and continuing until a free space is secured on the inner side; then more carefully opening towards the buccal division, until a slight space is made at this point. The file may be used at this stage to further open the space, and in bringing the surfaces into proper shape and smoothness. When the cavities are so large as is assumed above, there will usually be found so much disorganization of the enamel as to render necessary so much cutting to procure a

healthy surface as will open a space abundantly large for the subsequent work. If more is needed, it is secured by wedging; in any case a separation as large at the lower part as a No. 7 Froid file, and at the cervical part as a No. 3, is easily secured. The buccal space should be but slightly wedge-shaped, and somewhat smaller than the palatal, for reasons which will appear in the proper place.

After removing the softer caries, the walls of the cavity are prepared for the reception of the filling; the overhanging masticating plate being first cut away in a circular form on a line with the bottom or pulp wall, so that by direct approach every part of the cavity is accessible to slightly curved or even straight instruments. This opens the whole cavity to view. The instrument best adapted for this purpose is the gouge-shaped chisel, which cuts with exceeding keenness, and produces the form desired at this part. The removal of this portion of the enamel is an important and indispensable step in the improvement I am pursuing. It is practiced by the better operators to a somewhat less degree, and is in many cases an advantage to the organ. No other argument to defend this course may be used than that in these fillings, so difficult of execution, everything subservient to better performance must be followed out which is not injurious to the strength and preservation of the organ. It will often prove true here, as elsewhere in surgery, that something must be taken to save the remainder.

The cervical wall is now cut at a right angle to the proximal surface, taking care to remove from the surface of the tooth beneath the gum any half-decomposed enamel which may be present at this part. No retaining groove or pits are needed on this wall.

The buccal and palatal walls are next smoothly cut, and on the side of each, where they have sufficient strength, a shallow, round-bottomed groove is made the whole length, and terminating at the very *surface of the masticating plate of enamel.* The outer retaining groove should be near the margin, to avoid any approach to the pulp; the inner one should be nearer the bottom of the cavity, so that, in the subsequent cutting away of a portion of the palatal wall in the finishing process, the hold of the gold may not be obliterated. The instruments best adapted for this grooving are

made by filing a straight point quite round and small, then bending at a suitable angle, and shaping so as to have the edge at the inner side of the curve. Instruments of this form are better adapted for cutting the hard dentine and enamel than any others, for the reasons that they may be made harder than usual without danger of breakage; they cut with more keenness, do not chatter, leave the surface without sharp lines, and in grooving each cut follows in the last with certainty. They are directly reverse in form to the hoes and excavators in general use.

The pulp wall of the cavity is not altered in the form it presents after the removal of the caries.

The next and very important step is to remove the sharp corners of the mouth of the cavity; and at every part well polish it with pumice-stone; this facilitates the passage of the gold over the surface and the perfect contact of the foil with every part. This polishing is rapidly done by rotating a piece of boxwood armed with pulverized pumice.

Selection is now made of one of the appliances figured below, which are intended to give form to the outer surface of the filling, and are called matrices for this reason. These little affairs are made of a variety of shapes, sizes, and thickness. They are formed of slightly wedge-shaped pieces of steel, and are, as the cut designates, hollowed out at their thicker edge, which depression terminates at the thinner edge. At the part of the depression designed to give shape to the buccal edge of the filling the cut is generally abrupt and deep; at the inner portion it is more shallow and more inclined. It will be observed that the depression widens as it passes toward the thinner edge to follow the usual form of proximal cavities.* The lower and thin edge is rounded, to outline the curved margin of the cervical wall, and to effect pressure upon either the gum or the appliances used to stop the escape of mucus and blood from this tissue.

Fig. 129.

The plane parts of the face are file-cut or coarsely draw-filed. The reverse side, represented in Fig. 130, and which for conveni-

* In Fig. 129 the boundary of the right end of the depression should be similar to the other end.

ence of description is divided into three sections, is in most cases plane and smooth, excepting at the section *c*, which is file-cut. It is often necessary to have this side in two surfaces; one section, *a*, parallel with the plane parts of the face, and from this point inclining to a thin edge.

Fig. 130.

A very desirable form is to have section *c* bent backwards to follow the incline of the proximate tooth beneath the gum. At each end a square-cut is made to fit the plier ends represented at Fig. 131. After being formed, they are protected from oxidation, heated to redness, plunged in the cold bath, and temper drawn to near blueness; after polishing the depression, they will be ready for use. Quite a number of pairs are necessary to meet the requirements of the differing cases; but for the ordinary-sized simple proximal cavities, a dozen pairs varying in width, in thickness, and in size of depression, are all that I have found necessary. Fig. 129 represents the largest size required, those in most use not being more than from one-half to two-thirds this width and thickness. The character of these modifications will depend somewhat upon the desired end, since either a flat, contour, or excessively convex surface may be produced at the pleasure of the operator, or to suit the needs of the individual operation, by varying the form and depth of the depression. It is also occasionally necessary to have a matrix of unusual form to meet special cases, where the space is extremely great, or where, from the fracture of the outer plate of enamel, a steel one will not remain in position; for this purpose I have found hard boxwood to answer quite well. Silver also, in such cases, will occasionally be found useful. I sometimes take an impression of the immediate part to assist me in the fabrication of a suitable appliance. I have also made double-faced ones, which are so formed as on one adjustment to allow both cavities to be filled. For isolated teeth having large posterior cavities, a ring of silver may be used, carrying out the same principle in forming the portion which bounds the cavity. I have used the same plan in buccal cavities.

Fig. 131.

The selected matrix should, at the convex edge, be a little thinner than the space between the teeth at their closest part by

the gum; it should pass above the edge of the cervical wall, and should conform at this part to the contour of the tooth; the lower and thicker edge should reach nearly to the masticating surface, and this edge should not entirely fill the lower part of the space; above all, the depression at every part of its border should extend slightly beyond the edge of the cavity.

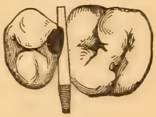
After having secured the cervical part of the case from the encroachment of moisture—by means of the rubber dam, or, when this is not applicable, wedges of wood, little rings of india-rubber, the string dam, short pieces of waxed twine, of such size as to remain firmly in place when drawn between the teeth, the application of dilute chloride of zinc, etc., or a combination of two or more of these means—the matrix is taken up in the pliers (Fig. 131), and pushed upward until it presses upon the gum or the appliances, and until it impinges tightly between the teeth. It is now wedged firmly against the tooth to be operated upon with little boxwood wedges; these secure it in place during the packing. It is well usually to insert two wedges, one from the buccal side between the teeth near the margin of the gums, and one from the palatine or lingual side nearer the masticating surface of the teeth than the margin of the gum; thus the matrix will be firmly keyed to its proper position. When the matrix passes up to the proper point, the wedging towards the cavity throws the lower edge against and somewhat beneath the projecting swell of enamel of the neighboring tooth, which adds to the security. However tightly the matrix may fit between the teeth, it will not frequently retain its fixedness unless securely wedged. Boxwood answers for this purpose better than any substance I have employed, for the reason that it is so hard as to be unyielding, and on this account also does not require to be more than pushed into the space. The wedges should be made to conform in size and shape to the space they are intended to occupy, in order that they may the more firmly retain their position when inserted. Moistening them with a solution of gum sandarac or mastic adds much to their security in position after they are introduced. The pliers (Fig. 131) are adapted to their introduction.

In case the adjoining teeth are not in contact, it is always necessary to introduce a wedge between them, to give greater firmness

to the teeth and less discomfort to the patient. In all large cavities I fix the matrix previous to introducing the napkins. Where the rubber dam is required, it precedes this appliance, which may aid in keeping the rubber in place.

For the small cases, the drying is done first, the napkins applied, and a hard rope of bibulous paper is passed against the gum, followed by the matrix. Fig. 132 represents the appearance of the parts at this stage, except the wedges, which are not shown. When the cavity is now examined, it will be found to present an open mouth, formed by its curved lower edge of enamel, and by the boundary of the matrix, through which funnel-shaped opening every part of the space is easily seen and directly touched. The case is now ready for the reception of gold.

Fig. 132.



I use for the upper half or more of the filling, ribbons of Nos. 4, 5, or 6, of non-cohesive gold, not annealed. These ribbons are made of one-fourth to whole sheets of foil, depending on the size of the space, and then folded into blocks, varied in length by the requirements of the case. For the lower third I prefer rolled gold of No. 20 to 30, of the most adhesive character, and annealed. I also use for this part in many cases "Eureka gold filling," No. 15, with the greatest advantage, taking up one or more of the shreds, and working them in wherever needed. The first block or mat is passed up toward the outer border, until it reaches the cervical wall, when the lower end is pushed into place, and fastened by pressure into the upper part of the retaining groove. The second piece is secured in the same manner in the inner or palatal groove; a further piece is forced between the two, and directly against the cervical wall. When a sufficiency of gold is placed upon these parts to save the tooth from contact of the points, the gold is securely malleted against the walls at all points, paying particular attention to the junction of the tooth with the matrix. In this way I proceed, successively introducing and malleting, until the cavity is two-thirds filled, not hastening further at any point, unless the assurance is reached that the gold is perfectly consolidated. At this point I commence and continue the

employment of heavy gold, the first pieces of which should be well fixed in the gold previously introduced at the parts over the retaining grooves, and also worked well into the foundation. It is now a simple matter to fill up the remainder with quickness.

In case there should happen to be an encroachment by moisture at near the close of the packing, the gold may be made smooth on the exposed surface, dried, and the latter part inserted, with all the characteristics of a separated filling. The form of the last third is such that, if inserted with dryness, no portion can escape. The matrix should now be removed.

It will be found, if the selection and adjustment of the matrix has been correct, that very little filing and cutting down of the plug will be required, and, in case the packing has been carefully performed, that the gold will be solidly condensed at every part. It will also be noticed that, while the gold is solid, it will not have become hardened in temper on the proximal surface, but yields laterally under the burnisher, not unlike lead or tin.

I must at this point call attention to the importance of the adaptation of the filling material to the cervical wall, which it requires no words to show will be secured by this method. There can hardly be a question that the general failure of proximal fillings is due to one or both of two causes,—the imperfect preparation of the cavity, and the want of solidity and adaptation of the gold at this part. When the filling extends to the gum or beneath it, and the teeth are not permitted to come into apposition here, this portion of the tooth, when well protected, is *least liable to decay*, *as this is not the place where caries usually commences.* And when the filling reaches to the cementum, the recurrence of caries is still less to be apprehended, since it is a clearly established, but apparently overlooked, principle that this structure is the least liable of the dental tissues to destruction. It will be noticed how seldom failures occur along the cervical edge of gutta-percha fillings, even when carelessly performed. These considerations have been forcing many to seek for better means of securing adaptation, solidity, and smoothness at this part.

The instruments for introducing the filling are of simple forms and direct action, but they should be in fine condition,—that is,

the points should be well serrated, and sharp. The only important modification needed are some pairs of mated pluggers, formed as at Fig. 133, in which one side of the edge is considerably longer than the other, which longer side, in malleting, is constantly kept against the matrix; this effects the greatest pressure upon the margins, and secures with positiveness the perfect fullness and the proper consolidation of the gold at these parts. Several sizes and varied curves of this point are required.

Fig. 133.

The finishing of the case is not different from the usual course pursued. In my own practice I open still further the inner portion of the space, which is easily done with chisels and suitable files. The peculiar form of the depression in the matrix produces a space which is considerably greater on the inner side, and which may be increased at pleasure. In many cases, where the tendency to caries is very great, I chisel quite freely from the inner plates of enamel, doing this after both the adjoining fillings are inserted, cutting down both gold and enamel together, allowing the fillings to touch only at the prominent outer part. The result is then an imitation of the exceedingly oval bicuspid, the immunity from decay of which all must have seen examples.

Fig. 134 represents a transverse section of two cases at a point immediately above the grinding surface, which exhibits the outline of the form of the cavity and finished surface of the gold.

Fig. 134.

In full confidence, founded on considerable trial, I claim that this method of filling large distal-proximal cavities overcomes several of the chief difficulties and deficiencies hitherto experienced, as well as enables greater facility of performance, and the security of excellent results."

SECTION E.—SALICYLIC ACID.

This preparation, though but recently introduced, promises much as a therapeutic agent in dental practice.

The following quotations from those who have given it attention and considerable investigation, will convey some idea of its uses and value.

The following, from the *Chemist and Druggist*, indicates much as to its properties and characteristics. T.

The dominion of "elegant pharmacy" has been extended; antiseptics and deodorisers may no longer boast of an exclusive privilege to be as disagreeable and abominable as they please; an aristocratic first cousin to carbolic acid has entered into trade, and is rapidly proving to demonstration the superiority of "blue blood." The advent, commercially, of salicylic acid as a substitute for carbolic acid may well be regarded as a great stride for those who cultivate "elegance" as well as utility and efficacy, for the former substance appears to possess a degree of antiseptic power equal, if not superior, to that of the latter; and while carbolic acid possesses a disagreeable smell and other unwholesome properties, salicylic acid appears as a crystalline powder, nearly colorless, possessing a very faint sweet taste, and almost without any injurious action on the health.

Salicin is the well-known vegetable principle existing in various species of the willow, poplar, and other trees and plants. Salicylic acid is a derivative of salicin.

The little that was known of the physiological and pathological effects of salicin sufficed, at least, to draw attention to those of its derivatives, and especially to salicylic acid, which has been the subject of occasional comment in the scientific journals for some years past. That it was peculiarly and powerfully effectual to suspend or entirely prevent fermentation and putrefaction has only quite lately been recognized by the Germans, who soon found that its natural sources, as above alluded to, were quite inadequate to enable the manufacturer to produce it in the quantities and at the

price that might soon become almost a necessity. Kolbe, Professor of Chemistry at the University of Leipsic, took the matter up, and recognizing the fact that phenol or carbolic acid might be so split up as to produce, amocg other substances, salicylic acid, he devised a process for its manufacture which is now practically employed at a chemical works at Dresden.

Phenate of sodium is first prepared by double decomposition of phenol of soda, and well-dried carbonic anhydride is then passed through the dry powder at a temperature of 110 degrees to 250 degrees C. The carbonic anhydride combines directly with the metallic derivative of phenol, and alkaline salts of acids of a higher series are formed; among these salicylate of sodium is dissolved in water and treated with hydrochloric acid, which by double decomposition sets free salicylic acid in small crystals. These crystals are washed, dissolved in hot water, and by recrystallization obtained in the form of a crystalline powder of a light brown color. The Germans attempt to bleach the product so obtained, and provide an article at a very high price which is sometimes quite white, but most of that in the market at a more moderate price is of a light cream color with a reddish tinge. Dr. Squibb thinks that the unbleached salicylic acid is, probably, of sufficient purity for nearly all, if not all, the practical purposes to which the acid is applied, while expensive chemical processes have to be employed in order to remove the small amount of coloring matter, which more than doubles the cost of production. Common sense seems to show that the coloring matter present is not of a kind, nor present in sufficient quantity, to interfere with the efficacy of the unbleached product, while the high price required for the more or less bleached product would shut out from employment for most purposes, whatever might be its powers.

Dr. Squibb describes the bleached or unbleached acid as occurring in minute broken acicular crystals, which give it the appearance of a granulated powder, soft and smooth under the pestle or knife, but somewhat rough or resinous when rubbed between the fingers. This powder is odorless and nearly tasteless. It has, however, a sweetish and astringent after-taste, with slight acridity in the fauces, but none in the mouth; and though tasteless, it leaves

a disposition or inclination to expectorate, which continues for some time.

Salicylic acid is very difficultly soluble in cold water, but easily dissolved by hot water, alcohol and ether. An aqueous solution containing from 0.2 to 0.4 per cent. of salicylic acid may be obtained by cooling a hot solution, when the excess crystallizes out. The acid is far more soluble in water containing a small portion of neutral salt. In Germany a solution is used for surgical purposes which contains one gramme of the acid dissolved in fifty grammes of water containing three grammes of sodium phosphate. Salicylic acid is decomposed into phenol and carbonic anhydride.

Its compounds with the bases or salts seem difficult to make, but salicylate of zinc, a crystalline salt moderately soluble in water, and salicylate of quinine, amorphous, insoluble in water but soluble in alcohol, have already been prepared in Germany.

Dr. Squibb very properly points out that it is in all probability a purely accidental, although a very curious, circumstance, that a substance of long and well-established character as an anti-ferment should offer a molecular constitution so well adapted to be broken up into a still more powerful anti-ferment, for there is no relation whatever, either in composition or chemical or physical properties, between carbolic acid and salicylic acid, except in their effects by similar or altogether different reactions. Accordingly, it must not be hastily assumed that in salicylic acid we have simply carbolic acid under a new name, but the compound must be experimentally tested, compared, and then judged on its merits. Numerous experiments reveal the fact that salicylic acid is a powerful antiseptic; indeed, it is asserted to be far more powerful and effective in smaller quantities than any other antiseptic. Consequently its innocuous character, and the absence of odor and taste which characterize it, make it immeasurably superior to carbolic acid, which possesses qualities sufficient to restrict its application within very narrow limits. Other advantages which salicylic acid is said to possess beyond all other antiseptics are, first, that it may be used in quantities sufficient to be completely effectual for surgical purposes, and yet devoid of any irritating action on the living tissues, nor does it produce inflammation, nor any caustic or corro-

sive effect in any quantity. Although the very small quantities that are effectual are quite neutral, it is admitted that large quantities may be irritant or painful, but not beyond what may be described as a stimulant. Secondly, it is said to have power over processes of decomposition which are beyond the reach of all antiseptics or anti-ferments, since it entirely suspends the chemical vitality which causes the production of the volatile oils in mustard, and bitter almonds, the effect of diastase, etc. Thirdly, it has no poisonous effect in any reasonable quantity.

Brewer's yeast does not effect a solution of glucose to which one-thousandth part of salicylic acid has been added. Mustard flour, which, when treated with a little tepid water, almost immediately develops a sharp odor of essence of mustard, remains quite inodorous if a small quantity of salicylic acid be added. The action of emulsin, the ferment contained in sweet or bitter almonds, or amygdalin, contained in bitter almonds only, whereby essence of bitter almonds is produced, is entirely prevented by salicylic acid. Fresh milk mixed with 0.04 per cent. of salicylic acid and allowed to stand at a temperature of 80° F. in an open vessel took thirty-six hours longer to curdle than the same quantity similarly exposed in a pure state. The neutral salts of salicylic acid do not, according to Kolbe, produce this effect, but only the free acid. Beer containing one-thousandth part of salicylic acid did not become sour when exposed to the air, neither did it exhibit any trace of that cryptogamic vegetation which appears on the surface of spoiled beer. Eggs which have been plunged in a solution of salicylic acid for one hour remained unaffected for three months. Fresh meat on which the acid had been sprinkled remained sweet for several weeks. It prevents or arrests the souring of worts, washes and beers of the brewers, and the putrefactive changes which are so troublesome to the glue manufacturers. Urine to which some salicylic had been added was, on the third day, still clear, and without ammoniacal odor. According to the results obtained by Professor Neugebouer, fermentation may be prevented by adding 100 grammes of salicylic acid to 1000 litres of beer. The same author recommends the use of a very weak solution of salicylic acid to rinse out wine casks, and thus hinder the formation of mould.

Small quantities of salicylic acid would also, in the estimation of Professor Neugebouer, if added to wine, prevent that after fermentation which is the principal cause of muddiness in wines, and perhaps check all the wine diseases produced by the growth of fungi. Professor Kolbe finds that a half a gramme of salicylic acid is sufficient to check the further progress of fermentation produced by the action of 5 grammes of beer yeast on a solution of 120 grammes of sugar in 1 litre of water. It has been suggested that such facts as these will indicate the quantities of salicylic acid to be used in the manufacture of fruit essences, champagnes, beer for exportation; and by way, perhaps, of reassurance to those who might object to be dosed continuously with a chemical of which we know so little as of salicylic acid, it is stated that Professor Kolbe could take without disturbing his digestion or general health from 1 to 1.25 grammes of salicylic acid per diem either in water or spirit. Surely, however, an isolated experiment of this kind is not enough to establish the harmlessness of the substance so as to warrant its recommendation for general employment in the preparation of articles of food.

Moreover Professor Kolbe proposes to use this substance for the prevention of putrefaction in water stored on board of ships, the object to be attained either by dissolving the salicylic acid in the water itself, in the maximum proportion of 1 to 20,000, or by covering the bung-holes of the water-casks with cotton impregnated with salicylic acid. Would the salicylic acid be quite harmless if used in the former way? A suggestion which we should feel much less hesitation in adopting personally is that a capital dentrifice may be made by perfuming an alcoholic solution of salicylic acid with oil of wintergreen. Used in small quantities, mixed with lukewarm water, it acts as an effectual preserver of the teeth; or an excellent tooth-powder may be prepared with salicylic acid. A "sprinkling-powder" for the feet has also been proposed, which acts without checking the perspiration. It should be composed of salicylic acid, talc, powdered soap, and starch. Besides removing odor, it communicates an agreeable softness to the feet.

The phosphate of sodium, with a solution of salicylic acid was employed by Professor Thiersch to promote the growth of skin over

granulated surfaces. Or salicylic acid used alone or mixed with starch was used upon contused or incised wounds, and in operations, with excellent general results, destroying the fetid odor of cancerous surfaces and pyæmic ulcerations.

We cannot over-estimate the importance of that branch of experimental inquiry which deals with such questions as the influence of agents like carbolic and salicylic acids on septic and zymotic poisoning. These investigations should be pushed to their farthest limit, even if not one in ten put forward by chemistry repay the labor of investigation, for it is certainly in this direction of research that medicine must look with greatest hope of success to control those abnormal vital processes which so far may be modified but not stopped. The phenols will always retain their importance among this class of agents, surpassing as they do all that have been tried before them. If salicylic acid should prove another step in advance, the gain will be great, more especially as indicating discoveries which may enable us to weild an undreamed-of-power against the most frightful and hitherto unconquerable ills of humanity.

In an article written under the title of salicylic acid, and for the *Deutsche Vierteljahrsschrift zur Zahnheilkunde*, by Dr. Ostermann, of Brunswick, reference is made to the experiments of Professor Kolbe, and says that in consequence of the successful results of the use of salicylic acid in the hospital, he was led to investigate it in its application to dentistry. Dr. Ostermann first communicated the results of his observations at the annual meeting of the Central Society of German Dentists.

The following extract, translated from the article alluded to, contains some of Dr. O.'s observations concerning the application of salicylic acid to dentistry. W. T.

In cases where the pulps of the teeth are changed through suppuration and gangrene into a foul, disagreeably-smelling, gas-evolving mass, it is well known that if they are filled without first restoring them to a healthy condition, periostitis will in all probability result. In such cases I introduce into the nerve canal salicylic acid and then make a temporary filling, which I allow to

remain for several days. In order to make the stopping more secure, I saturate a piece of spunk with an ethereal solution of salicylic acid, and with it fill the pulp chamber. The results in a large number of cases were good. The decaying, offensive nerves in the root canals become fully deodorized and shrink into a mumified detritus. Such detrital matter can neither by evolution of gas or putrid secretions irritate through the apicial foramen. I will here remark that it may be difficult to effectively introduce the dry salicylic acid into the root canals. If such be the case, we can have recourse with advantage to a concentrated solution of the acid in ether, which will volatilize in a very few moments. This course will be especially indicated in the molar teeth; in the incisor teeth and pulp cavities where cleansing can be conveniently performed it should never be neglected. After washing the canals with the above solution, we saturate a piece of spunk, place in the bottom, and then fill with any material that may be desirable.

In the treatment of suppurating pulps, dry salicylic acid may be employed with advantage. In erosion and in inflamed conditions of the mucous membrane and jaws, I have applied salicylic acid with success. In stomatitis and scorbutic inflammation of the jaws, where the borders and inter-dental papillæ appear degenerated, gangrenous, and are coated with a putrid stringy secretion, I have applied salicylic acid mixed with equal parts of powdered cassia and cinnamon with a soft brush. The foul taste accompanying such conditions, also the ill-smelling breath, soon disappear. It may here be added that in every inflammatory condition caused by roots dead or affected by periostitis, salicylic acid will prove an admirable remedy.

Aside from the application of salicylic acid in special cases, I have employed it as an every-day means of purifying the teeth and mouth, with the best results.

For a disinfecting mouth wash: One part of salicylic acid to three hundred parts of water will be sufficient, or if a stronger solution is required, it may be prepared by adding three parts of phosphate of soda and thirty parts of distilled water to one of salicylic acid. It forms a valuable addition to most tinctures and tooth powders.

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